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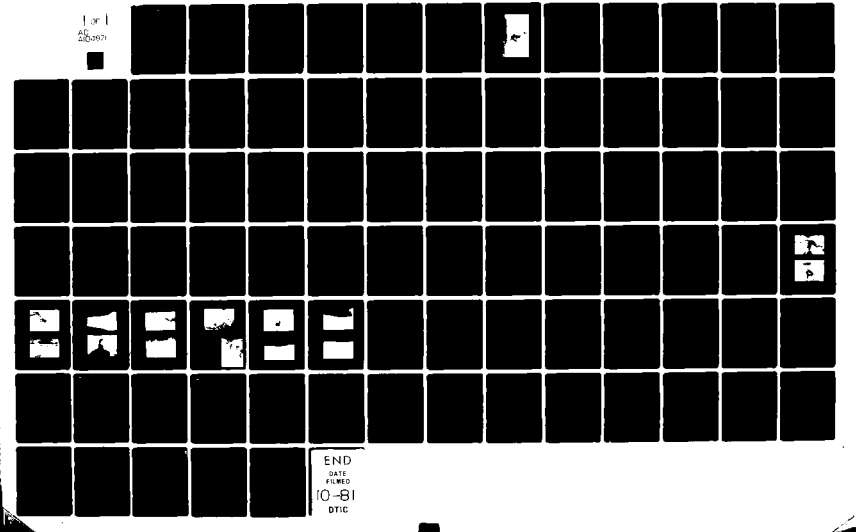

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MISSISSIPPI · KASKASKIA · ST. LOUIS BASIN

WAHOO LAKE DAM
ST. FRANCOIS COUNTY, MISSOURI
MO. 30155

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

JULY 1981

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

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Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Wahoo Lake Dam (Mo. 30155) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Wahoo Lake Dam (Mo. 30155).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

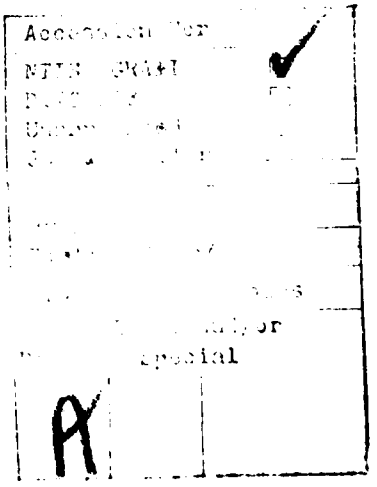
a. The combined capacity of the spillways will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED
Chief, Engineering Division — 17 JUL 1981 Date

APPROVED BY: SIGNED
Colonel, CE, Commanding — 20 JUL 1981 Date



WAHOO LAKE DAM
ST. FRANCOIS COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30155

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
PRC CONSOER TOWNSEND, INC.
ST. LOUIS, MISSOURI
AND
PRC ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO
A JOINT VENTURE

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

JULY 1981

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Wahoo Lake Dam,
Missouri Inventory No. 30155
State Located: Missouri
County Located: St. Francois
Stream: Unnamed tributary of Bee Run Creek
Date of Inspection: March 6, 1981

Assessment of General Condition

Wahoo Lake Dam was inspected by the engineering firms of PRC Consoer Townsend, Inc. of St. Louis, Missouri, and PRC Engineering Consultants, Inc. of Englewood, Colorado, (A Joint Venture) in accordance with the U. S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District of the Corps of Engineers. Based upon the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. Located within the estimated damage zone of less than three miles downstream of the dam are one downstream lake and dam (Timberline Lake Dam, Mo. 30156), several recreational areas, at least two dwellings in the lakeside development around the reservoir of Timberline Lake Dam, and one dwelling and a clubhouse downstream of Timberline Lake Dam, which may be subjected to flooding, with possible damage and/or destruction, and possible loss of life. Wahoo Lake Dam is in the small size classification since it is 33.9 feet high and has a maximum reservoir impoundment of 193 acre-feet.

The inspection and evaluation indicate that the dual spillway system of Wahoo Lake Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Wahoo Lake Dam being a small size dam with a high hazard potential is required

by the guidelines to pass from one-half of the Probable Maximum Flood to the Probable Maximum Flood without overtopping the dam. Considering the small size of the dam, the storage capacity of the reservoir and the small number of dwellings in the downstream hazard zone, one-half of the Probable Maximum Flood is considered the appropriate spillway design flood for Wahoo Lake Dam. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region. It was determined that the reservoir/spillway system can accommodate approximately 30 percent of the Probable Maximum Flood without overtopping the dam. The evaluation also indicates that the reservoir/spillway system will accommodate the one-percent chance flood (100-year flood) without overtopping the dam.

The overall condition of the dam and the spillways appears to be poor due to several deficiencies noted by the inspection team. The deficiencies included: the area of seepage, boggy ground and standing water observed downstream of the embankment, which will require immediate attention; the erosion observed in the spillway discharge channel; the deteriorated condition of the principal spillway pipes; the adverse alignment of the emergency spillway; the erosion of the upstream slope due to wave action and the lack of proper protection; a lack of a maintenance schedule which should include periodical maintenance of the vegetative cover on the embankment; and there also exists a need for periodic inspection by a qualified engineer. The lack of seepage and stability analyses on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described above.

Walter G. Shifrin, P.E.

Overview of Wahoo Lake Dam

NATIONAL DAM SAFETY PROGRAM

WAHOO LAKE DAM, I.D. No. 30155

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

WAHOO LAKE DAM, Missouri Inv. No. 30155

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for Wahoo Lake Dam was carried out under Contract DACW 43-81-C-0063 between the Department of the Army, St. Louis District, Corps of Engineers, and the engineering firms of PRC Consoer Townsend, Inc. of St. Louis, Missouri, and PRC Engineering Consultants, Inc. of Englewood, Colorado, (A Joint Venture).

b. Purpose of Inspection

The visual inspection of Wahoo Lake Dam was made on March 6, 1981. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project, presents a summary of visual observations made during the field inspection, presents an assessment of hydrologic and hydraulic conditions at the site and of the structural adequacy

of the various project features, and assesses the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing and detailed analyses were not within the scope of this study. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

It should be noted that in this report reference to left or right abutments is viewed as looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to the northeast abutment or side, and right to the southwest abutment or side.

d. Evaluation Criteria

The inspection and evaluation of the dam is performed in accordance with the U.S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District office of the Corps of Engineers for Phase I Dam Inspection.

1.2 Description of the Project

a. Description of Dam and Appurtenances

The following description is based upon observations and measurements made during the visual inspection and conversations with Mr. Brad Eisenbeis, the representative of the owner of the dam. No design or "as-built" drawings for the dam or appurtenant structures were available.

The dam is a rolled, earthfill structure with a core trench excavated along the axis of the dam, according to Mr. Eisenbeis. The alignment of the dam is straight between earth abutments. A plan and elevation of the dam are shown on Plate 4 and Photos 1

through 3 show views of the dam. The top of the dam has a length of 345 feet between the left abutment and the spillways, and an assumed minimum elevation of 835.0 feet above mean sea level (M.S.L.). From the left abutment, the top of dam slopes downward for 45 lineal feet with a drop in elevation of 3.9 feet. For the next 100 feet, the top of dam continues to slope downward with a drop in elevation of one foot. For the last 200 feet of the dam, the top of dam was surveyed to be level to the edge of the emergency spillway. The embankment has a top width of 19 feet and a maximum structural height of 33.9 feet. The downstream slope was measured to be 1 vertical to 2 horizontal (1V to 2H). The upstream slope varied from 1V to 2.25 from the top of the dam to the normal water surface level to 1V to 5H from the normal water surface level to the water surface level on the day of the inspection.

There are two spillways at the damsite that are referred to in this report as the principal and emergency spillway. The principal spillway consists of five, helically welded, steel pipes located on the right abutment (see Photo 5). A training berm perpendicular to the upstream slope of the dam defines the spillway entrance channel and isolates it from the embankment (see Photo 7). The pipes are 30 inches in diameter with a wall thickness of 1/16 of an inch. The invert elevation of the pipes varies from 829.4 feet to 829.6 feet above M.S.L. The pipes are 40 feet long and extend under the fill of an access road, which extends across the dam. The pipes discharge into an earth-lined channel. This discharge channel has a training berm on the left side, to direct flow away from the downstream slope of the embankment (see Photos 7 and 8). Approximately 200 feet downstream of the dam, the channel makes a 90 degree bend and directs flows toward Lake Timberline, which is located directly below Wahoo Lake Dam.

The emergency spillway is in essence a parabolic shaped, broad-crested weir constructed of fill material placed over the principal spillway pipes (see Photos 5 and 6). The spillway has a top width of 64.0 feet and a depth of 2.3 feet. The crest of the

weir is surfaced with asphalt. The invert of the spillway is located 20 feet to the left of the left-most principal spillway pipe, and has a crest elevation of 832.7 feet above M.S.L. Discharge over the spillway flows down a grass-covered embankment into the principal spillway discharge channel. Flow from the emergency spillway is directed away from the embankment by the training berm mentioned previously.

No low-level outlet or outlet works were provided for this dam.

b. Location

Wahoo Lake Dam is located in St. Francois County in the State of Missouri on an unnamed tributary of Bee Run Creek. The location of the dam on the 7.5 minute series of the U.S. Geological Survey maps is found in the southeast quadrant of Section 14 of Township 38 North, Range 4 East, of the Vineland, Missouri Quadrangle Sheet (Advance Print, see Plate 2). The dam is located approximately five miles north of Bonne Terre (see Plate 1).

c. Size Classification

The reservoir impoundment of Wahoo Lake Dam is less than 1,000 acre-feet but more than 50 acre-feet, which would classify it as a "small" size dam. The maximum height of the dam is less than 40 feet and greater than 25 feet, which also classifies it as a "small" size dam. The size classification is determined by either the storage or height, whichever gives the larger size category. Therefore, the size classification is determined to fall within the "small" category, according to the "Recommended Guidelines for Safety Inspection of Dams" by the U.S. Department of the Army, Office of the Chief Engineer.

d. Hazard Classification

The dam has been classified as having a "high" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. From a visual inspection of the downstream area, our findings concur with this classification. Located within the estimated damage zone, which extends less than three miles downstream of the dam, are one downstream lake and dam (Timberline Lake Dam, Mo. 30156), several recreational areas, at least two dwellings in the lakeside development around the reservoir of Timberline Lake Dam, and one dwelling and a clubhouse downstream of Timberline Lake Dam (see Photos 13 and 14).

e. Ownership

Wahoo Lake Dam is owned privately by Lake Timberline, Inc. The mailing address is Lake Timberline, Inc., c/o Mr. Brad Eisenbeis, 220 A Main Street, Festus, Missouri, 63028.

f. Purpose of Dam

The purpose of the dam is to impound water for recreational use as a private lake. Wahoo Lake is one of twelve lakes in the Lake Timberline lake development.

g. Design and Construction History

The dam was designed by Mr. Charles Dewey Craig, who is deceased. Lake Timberline, Inc. does not have any drawings or design information for the dam.

According to Mr. Eisenbeis, Wahoo Lake Dam was constructed in 1969 by Black Excavating Company of Bismarck, Missouri. The owner of Black Excavating Company was Mr. Paul Black. Mr. Eisenbeis believed that a core trench was excavated along the axis of the dam. However, Mr. Eisenbeis did not know of any other details concerning the construction of the dam.

h. Normal Operational Procedures

Normal procedure is to allow the lake to remain as full as possible with the water level being controlled by rainfall, runoff, evaporation, and the invert elevation of the principal spillway pipes.

1.3 Pertinent Data

a. Drainage Area (square miles):. 0.38

b. Discharge at Damsite

Estimated experienced maximum flood (cfs): . . . . . Unknown

Estimated ungated spillway capacity with reservoir at top of dam elevation (cfs): 449

c. Elevation (Feet above MSL)

Top of dam (minimum):. . . . . 835.0 (assumed)*

Spillway crests:

Principal Spillway . . . . . 829.4 (minimum)

Emergency Spillway 832.7

Normal Pool: 829.4

Maximum Experienced Pool:. . . . . Unknown

Observed Pool: 826.0

d. Reservoir

Length of pool with water surface at top of dam elevation (feet):. 1800

e. Storage (Acre-Feet)

Top of dam (minimum):. 193

Spillway crests:

Principal Spillway 113

Emergency Spillway 157

Normal Pool: 113

Maximum Experienced Pool: . . . . . Unknown

Observed Pool: 77

f. Reservoir Surfaces (Acres)

Top of dam (minimum):. 16.5

Spillway crests:

Principal Spillway 12.0

Emergency Spillway	14.5
Normal Pool:	12.0
Maximum Experienced Pool:	Unknown
Observed Pool:	9.5

g. Dam

Type:	Rolled, Earthfill
Length:	345 feet
Structural Height:	33.9 feet
Hydraulic Height**:	33.9 feet
Top width:	19 feet
Side slopes:	
Downstream.	1V to 2H (measured)
Upstream.	Varied from 1V to 2.25H (from the top of dam to the normal water surface elevation) to 1V to 5.0H (below the normal water surface elevation to the elevation of the water surface on the day of the inspection).
Zoning:	Unknown
Impervious core:	Unknown
Cutoff:	A core trench, according to Mr. Eisenbeis
Grout curtain:	Unknown
Volume:	23,800 cu.yds. (Estimated)

h. Diversion and Regulating Tunnel. . . . . None

i. Spillway

Type:	
Principal Spillway	Five, 30 inch diameter, helically welded, steel pipes, uncontrolled.

Emergency Spillway . . . . . .Parabolic-shaped, earthcut broad-crested weir with a top width of 64 feet and a depth of 2.3 feet, asphalt-lined, uncontrolled.

Location:

Principal Spillway . . . . . Right abutment

Emergency Spillway . . . . . Right abutment

Length of weir:

Principal Spillway . . . . . N.A.

Emergency Spillway . . . . . 0 feet

Crest Elevation (feet above MSL):

Principal Spillway . . . . . 829.4 (minimum)

Emergency Spillway 832.7

j. Regulating Outlets . . . None

* No exact elevation is known for the top of dam, therefore, an elevation was estimated from the Vineland, Missouri, U.S.G.S. Quadrangle sheet (Advance Print). This estimated elevation is referred to as an assumed elevation. All other elevations were determined from the assumed top of dam elevation and field measurements.

** The hydraulic height of the dam is the vertical distance from the lowest point on the downstream toe to the top of dam or the maximum water surface, if below the top of dam.

SECTION 2: ENGINEERING DATA

2.1 Design

The dam was designed by Mr. Charles Dewey Craig, who is deceased. Design drawings and calculations are not available for this dam.

2.2 Construction

Wahoo Lake Dam was built by Black Excavating Company of Bismarck, Missouri in 1969. No construction records or data are available relative to the construction of the dam.

2.3 Operation

No operational records are available for the dam.

2.4 Evaluation

a. Availability

No design drawings, design computations, construction data, or operational data are available. The engineering data used in this report was obtained from State Geological Maps, a general soil map of the State of Missouri published by the Soil Conservation Service, and U.S.G.S. Quadrangle Sheets.

b. Adequacy

The available engineering data was not sufficient for a definitive review and evaluation. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing and evaluating design, operation, and construction data, but is based primarily on visual inspection and past performance. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

No valid engineering data were available pertaining to the design or construction of the dam.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of the Wahoo Lake Dam was made on March 6, 1981. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Mark Haynes, P.E.	PRC Engineering Consultants, Inc.	Soils
Jerry Kenny	PRC Engineering Consultants, Inc.	Hydraulics and Hydrology
James Nettum, P.E.	PRC Engineering Consultants, Inc.	Civil-Structural and Mechanical
Razi Quraishi, R.P.G.	PRC Engineering Consultants, Inc.	Geology
John Lauth, P.E.	PRC Consoer Townsend, Inc.	Civil-Structural

Specific observations are discussed below.

b. Dam

The overall condition of the dam appears to be poor. Some items of concern were observed and are described below.

The top of dam is used by local residents to gain access to their homes. The surface of the top of dam consists of a hard packed clay with some gravel surfacing and evidence of a thin asphalt pavement (see Photo 2). Some damage due to vehicular traffic was observed, which consisted of a few three- to four-inch deep potholes. The top of dam does not support any vegetative cover; however, no erosion was observed. No depressions or cracks indicating a settlement of the embankment were observed. The variation in elevation across the top of dam did not appear to be due to an instability of the embankment; the top of dam was probably constructed this way to gain access from the dam to the left abutment. No significant deviation in the horizontal alignment was apparent. No evidence indicating that the dam has ever been overtopped was observed.

The upstream slope is not protected by riprap; however, a surficial layer of rock fragments was observed on the slope below the normal water surface level (see Photo 1). Some minor erosion and undercutting of the slope due to wave action was observed at the normal water surface level. The undercutting of the slope indicates that future sloughing of the slope is possible. The upper portion of the slope above the normal water surface level was adequately protected against surface runoff by a well maintained grass cover and no erosion due to surface runoff was present. No bulges, depressions or cracks indicating an instability of the embankment or foundation were observed on the slope.

The downstream slope is protected against erosion due to surface runoff by a good grass cover (see Photo 3). Several small saplings were also observed on the slope. No bulges, depressions or cracks indicative of a slope movement were apparent on the slope.

An area of flowing seepage, moist boggy ground, standing water, and cattails was observed along the toe of the dam. The area extended from approximately the maximum section of the dam at the left abutment to about 75 feet to left of the right end of the dam and from the toe of the dam to approximately the tailwater of Timberline Lake Dam. Flowing seepage was observed in two locations. One of the locations was at the extreme left hand side of the above mentioned area and the other location was approximately 30 feet to the right of the first location (see Photo 4). The cumulative rate of flow of the two areas of seepage was estimated to be from 3 to 4 gallons per minute and the discharge of the seepage was clear. The source of the seepage is unknown; however, due to the characteristics of the foundation bedrock (see Section 3.1c), it is most likely that the seepage is through the foundation and not the embankment.

Both abutments slope moderately upward from the dam. No instabilities were observed on either abutment. Two erosion gullies were observed on the right abutment along the access road (see Photo 6). The erosion does not appear to have an effect on the structural integrity of the abutment or embankment. No erosion, which was felt to be detrimental to the dam, was observed on the left abutment.

No evidence of burrowing animals was apparent on either the embankment or the abutments.

c. Project Geology and Soils

(1) Project Geology

The damsite is located on an unnamed tributary of Bee Run Creek in the Salem Plateau section of the Ozark Plateaus Physiographic Province. Deep dissection of topography by major streams is one of the important characteristics of the Salem Plateau section. There is a wide distribution of dolomites and limestones in the Salem Plateau. Cuestaform topography is exhibited in this plateau section consisting of two major escarpments, namely the Crystal

Escarpment and Burlington Escarpment. Deep dissection in dolomites and limestones is a major factor in the development of many springs in this area. A major component of surface discharge of water to the regional drainage is contributed by these springs.

The topography in the vicinity of the damsite is hilly with V-shaped valleys. Elevations of the ground surface range from 1034 feet above M.S.L. nearly 1.7 miles northeast of the damsite to 835 feet above M.S.L. at the damsite. The reservoir slopes are generally from 14- to 28-degrees from horizontal. The reservoir slopes are stable. The area near the damsite is covered with residual soil deposits consisting of a reddish-brown, moderately plastic, silty clay with some fine to medium sand and occasional 1/4 inch size rock fragments.

The regional bedrock geology beneath the residual soil deposits in the damsite area as shown on the Geologic Map of Missouri (1979) (see Plate 6) are of the Ordovician age rocks consisting of Powell Dolomite, Cotter Dolomite, Roubidoux Formation, and Gasconade Dolomite; the Cambrian age rocks consisting of Lamotte Sandstone, Potosi Dolomite, and Franconia and Bonneterre Formations; and the Precambrian age rocks consisting of St. Francois Mountains Volcanic and Intrusive. The predominent bedrock underlying the residual soil deposits in the vicinity of the damsite are the Cambrian age rocks consisting of Potosi Dolomite, and Franconia and Bonneterre Formations.

Outcroppings of Cambrian Potosi Dolomite (dark brown to pinkish white, fine to coarse grained, cherty, highly to moderately weathered, slightly to moderately hard, dolomite) are exposed in the discharge channel of the spillways and in the upstream area of the left abutment (see Photos 10 and 11). Intense solution activity, high intensity weathering, and secondary sedimentary internal structures (such as spherulites and concretions) were observed in the rock outcroppings.

No faults have been identified in the vicinity of the damsite. The closest trace of a fault to the damsite is the Big River fault system nearly three miles south of the damsite. The Big River fault had its last movement in the Ordovician time. Thus, the fault system has no effect on the damsite.

No boring logs or construction reports were available that would indicate foundation conditions encountered during construction. Based on the visual inspection and conversations with Mr. Eisenbeis, the embankment probably rests on the highly weathered Cambrian Potosi Dolomite bedrock with the core trench excavated to the underlying bedrock. The dual spillway system rests on the residual soils of the right abutment.

(2) Project Soils

According to the "Missouri General Soil Map and Soil Association Description" published by the Soil Conservation Service, the materials in the general area of the dam belong to the soil series of Union-Goss-Gasconade-Peridge in the Ozark Border Association. The soils are basically formed from loess deposits and weathered bedrock. These soils vary from a slowly permeable silty clay to moderately permeable silt loam.

Material removed from the embankment slopes was a reddish-brown, moderately plastic, silty clay with some fine to medium sand and some rock fragments. Based upon the Unified Soil Classification System, the soil would probably be classified as a CL. This is an impervious soil type, which generally has the following characteristics: a coefficient of permeability less than one foot per year, medium shear strength, and a high resistance to piping. This soil type also has a high resistance to erosion under low velocity flow; however, excessive erosion can occur during the high velocity flows that can be expected when the dam is overtopped.

d. Appurtenant Structures

(1) Principal Spillway

All five of the spillway pipes are rusted and the inlet invert of two pipes has been completely corroded away (see Photo 9). The configurations of all the pipes are deformed to varying extents (see Photo 5). Undermining of the pipe inlet and outlet areas was evident. The outlet invert of one pipe was also corroded away. There was a meandering erosion gully in the spillway discharge channel extending approximately 200 feet downstream of the pipe outlets (see Photo 8). At this point, the channel contained an eroded drop-off of about 15 feet (see Photo 10). The remainder of the channel to the Lake Timberline outlet was clogged with trees and debris and was severely eroded.

(2) Emergency Spillway

The invert of the emergency spillway is partially obstructed at the entrance by the upstream training berm and at the exit by the downstream training berm. The asphalt crest covering has deteriorated, and the grass covering of the inlet and outlet embankment was sparse. Therefore, flow through the spillway must make two directional changes on erodible surfaces.

(3) Outlet Works

No low-level outlet or outlet works were provided for this dam.

e. Reservoir Area

The reservoir water surface elevation at the time of the inspection was 826.0 feet above M.S.L. The reservoir has a normal water surface elevation of 829.4 feet above M.S.L. and a surface area of 12 acres at the normal water surface level.

The rim appeared to be stable with no erosional or stability problems observed (see Photo 12). The land around the reservoir slopes gently to moderately upward from the reservoir rim and is mostly wooded with grassy slopes. Several houses are built around the reservoir rim. No evidence of excessive siltation was observed in the reservoir on the day of the inspection.

One dam located upstream of Wahoo Lake was considered to be large enough to have an effect on the flood routing evaluation for Wahoo Lake Dam, as further discussed in Section 5 (see Plate 2). The dam was built within the last year and is called Oak Park Lake Dam.

f. Downstream Channel

There is no downstream channel. The discharge channel of the spillways discharges directly into the reservoir of Timberline Lake Dam (Mo. 30156).

3.2 Evaluation

The visual inspection did not reveal any conditions which were felt to pose an immediate threat to the safety of the structure; however, the following condition does exist which warrants prompt attention.

The area of seepage, boggy ground and standing water observed at the downstream toe of the dam could affect the structural stability of the dam; however, it does not constitute an unsafe condition at the present time. Due to the rate of flow and the characteristics of the foundation bedrock, it was felt that the observed seepage was through the foundation bedrock and not the embankment. This would have less of an adverse effect on the dam at this time. Nevertheless, with time, this condition can only worsen.

The following conditions were observed which could adversely affect the dam in the near future and will require maintenance within a reasonable period of time.

1. The deteriorated condition of the principal spillway pipes could pose a potential hazard to the normal operation of the spillway. This coupled with the undermining of the pipes could jeopardize the safety of the spillway and the dam.

2. The erosion in the spillway discharge channel, if allowed to continue, could endanger the stability of the principal spillway and thus the dam.

3. The obstructions of the emergency spillway increase the erosion potential of the discharge through the spillway. Future flows through the spillway could result in damage that could adversely affect the stability of the dam.

4. The wave erosion on the upstream slope does not appear to affect the stability of the dam in its present condition. However, continual erosion of the slope can only be detrimental to the structural integrity of the dam.

5. The vegetative cover on the embankment slopes appeared to be adequate protection against erosion due to surface runoff and sufficently maintained at this time. Nevertheless, with neglect and improper maintenance procedures, this condition could deteriorate to the point where it could affect the safety of the dam.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

There are no specific procedures which are followed for the operation of this dam. The water level below the invert of the principal spillway pipes is allowed to remain as high as possible.

4.2 Maintenance of Dam

Wahoo Lake Dam is maintained by Lake Timberline, Inc., which assesses property owners a fee for maintenance of the development, lakes and dams.

Small saplings and brush were removed from the downstream slope of the dam and piled in a row along the toe and abutment contacts of the dam in December of 1979. Mr. Eisenbeis indicated that Lake Timberline, Inc. plans to burn the remaining vegetation off of the downstream slope in the near future. Considerable damage has occurred to the spillway system consisting of corrosion and undermining of the principal spillway pipes, and erosion in the discharge channel, which will require maintenance.

No major repairs or modifications have been made to the dam since its original construction.

4.3 Maintenance of Operating Facilities

There are no operating facilities associated with this dam.

4.4 Description of Any Warning System in Effect

The inspection team is not aware of any warning system in effect for this dam, such as an electrical warning system or a manual warning notification plan.

4.5 Evaluation

Although the maintenance of Wahoo Lake Dam seems to be somewhat lacking, the dam does not appear to be neglected. The remedial measures described in Section 7 should be undertaken to improve the condition of the dam.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

No hydrologic and hydraulic design data are available for Wahoo Lake Dam. The sizes of physical features utilized to develop the stage-outflow relation for the spillway and overtopping of the dam were prepared from field notes and sketches prepared during the field inspection. The reservoir elevation-area data were based on the U.S.G.S. Vineland, Missouri Quadrangle topographic map (Advance Print, 7.5 minute series). The spillway and overtop release rates and the reservoir elevation-area data are presented in Appendix B.

The hydrologic soil group of the watershed was determined from information available in the U.S.D.A. Soil Conservation Service publication "Missouri General Soil Map and Soil Association Descriptions", 1979. The Probable Maximum Precipitation (PMP) used to determine the Probable Maximum Flood (PMF) was determined by using the U.S. Weather Bureau publication "Hydrometeorological Report No. 33" (April 1956). The 100-year and the 10-year floods were derived from the 100-year and the 10-year rainfall, respectively, of Ste. Genevieve, Missouri.

b. Experience Data

Records of reservoir stage or spillway discharge are not maintained for this site. However, no evidence was observed which would indicate that the dam had ever been overtopped.

c. Visual Observations

Observations made of the spillways during the visual inspection are discussed in Section 3.1d and evaluated in Section 3.2.

d. Overtopping Potential

Both the Probable Maximum Flood and one-half of the Probable Maximum Flood, when routed through the reservoir, resulted in overtopping of the dam. The peak inflows of the PMF and one-half of the PMF are 5,738 cfs and 2,023 cfs, respectively. The peak outflow discharges for the PMF and one-half of the PMF are 4,396 cfs and 1,487 cfs, respectively. The maximum capacity of the spillways just before overtopping the dam is 449 cfs. The PMF overtopped the dam by 2.34 feet and one-half of the PMF overtopped the dam by 0.98 feet. The total duration of flow over the dam is five hours during the occurrence of the PMF and two hours during one-half of the PMF. The spillway/reservoir system of Wahoo Lake Dam is capable of accommodating a flood equal to approximately 30 percent of the PMF just before overtopping the dam and will also accommodate the one-percent chance flood (100-year flood) without overtopping the dam. The analysis of Wahoo Lake Dam included the hypothetical breach of the upstream dam, Oak Park Lake Dam, for those floods which overtop the upstream dam.

The surface soils on the embankment and in the spillway discharge channel consist of a silty clay. The spillway discharge channel and the top of dam have no protective covering. The dam will be overtopped by approximately one foot during the occurrence of the one-half PMF. Severe erosion to the embankment due to the high velocity of flow on its downstream slope during overtopping could occur, which could lead to the eventual failure of the dam. The maximum velocity of flow in the discharge channel of the spillways during the one-half PMF will be about 6.5 ft/sec, which

could also cause excessive erosion in the spillway channel due to the high velocity of flow.

The failure of the dam could cause extensive damage to the property downstream of the dam and possible loss of life. The estimated damage zone extends less than three miles downstream of the dam. Located within the damage zone are one downstream lake and dam (Timberline Lake Dam, Mo. 30156), several recreational areas, at least two dwellings in the lakeside development around the reservoir of Timberline Lake Dam, and one dwelling and a clubhouse downstream of Timberline Lake Dam.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There were no major signs of settlement or distress observed on the embankment or foundation during the visual inspection. The stability of the dam does not appear to be in jeopardy at this time; however, continual deterioration of the dam due to neglect and improper maintenance can only endanger the structural integrity and safety of the dam. The area of seepage observed downstream of the dam could also be detrimental to the stability of the embankment, but it does not appear to constitute an unsafe condition at this time. The wave erosion on the upstream slope does not appear to endanger the structural stability of the embankment in its present condition; however, continual erosion of the slope could be detrimental to the embankment. In the absence of seepage and stability analyses, no quantitative evaluation of the structural stability can be made.

The structural stability of the principal spillway appears to be in jeopardy due to the extent of corrosion, deformation, and undermining of the pipes. Nevertheless, the pipes are unobstructed and should be able to operate. The structural stability of the emergency spillway is impaired due to the obstruction presented by the training berms. However, it is felt that the stability of both spillways do not constitute an immediate safety hazard to the dam.

b. Design and Construction Data

No design computations pertaining to the embankment were uncovered during the report preparation phase. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. No embankment or foundation soil parameters were available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction were available for use in a stability analysis.

c. Operating Records

No operating records are available relating to the stability of the dam or appurtenant structures. The water level on the day of inspection was 3.4 feet below the crest of the principal spillway; however, the reservoir is assumed to remain close to full most of the time.

d. Post Construction Changes

No post construction changes to the embankment are known to exist that will affect the structural stability of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 2, as defined in the "Recommended Guidelines for Safety Inspection of Dams" as prepared by the Corps of Engineers (see Plate 9). Seismic Zone 2 is characterized by a moderate earthquake hazard. An earthquake of the magnitude that would be expected in Seismic Zone 2 should not cause significant distress to a well designed and constructed earth dam. Available literature indictes that no active faults exist near the vicinity of the damsite. The maximum recorded historic magnitude earthquake in the immediate vicinity of the damsite was the July 21, 1967 event of magnitude 4.4 located at a distance of 35 miles

southeast of the damsite. This event cannot be correlated with known tectonic structure and is considered to probably be related to the release of accummulated residual strain along a buried pre-Quaternary fault. The attenuation of this event to the damsite would produce a peak ground acceleration of less than 0.05g which would not produce a significant seismic impact on the dam.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and the visual inspection. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based upon observations of field conditions at the time of the inspection along with data available to the inspection team.

It is also important to realize that the condition of a dam depends upon numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be assurance that an unsafe condition could be detected.

a. Safety

The spillway capacity of Wahoo Lake Dam is found to be "Seriously Inadequate". The spillway/reservoir system will accommodate about 30 percent of the PMF without overtopping the dam. If the dam is overtopped, the safety of the embankment would be in jeopardy due to the susceptibility of the embankment materials to erosion. High velocity of flow on the downstream slope of the dam could cause excessive erosion and eventually lead to a failure of the dam. The dual spillway system would also receive considerable damage during the occurrence of a severe flood.

The overall condition of the dam and spillways appears to be poor. Several items of concern were noted, which will require attention. A quantitative evaluation of the safety of the embankment could not be made in view of the absence of seepage and stability analyses. The present embankment and spillway system, however, appear to have performed satisfactorily since their construction without any apparent failures. No evidence that the dam has ever been overtopped was observed. The safety of the dam can only be improved if the deficiencies described in Sections 3.2 and 6.1a are properly corrected as described in Section 7.2b.

b. Adequacy of Information

The conclusions presented in this report are based upon field measurements, past performance and the present condition of the dam. Information on the design hydrology, hydraulic design, operation, and maintenance of the dam was not available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency

The items recommended in Paragraph 7.2a and the first item in paragraph 7.2b should be pursued on a high priority basis. The remaining remedial measures recommended in Paragraph 7.2b should be accomplished within a reasonable period of time.

d. Necessity for Phase II Inspection

Based upon results of the Phase I inspection, and if the remedial measures recommended in Paragraph 7.2 are undertaken, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives

There are several options that may be considered to reduce the possibility of dam failure or to diminish the harmful consequences of such a failure. Some of these options are:

1. Increase the capacity of the spillways to pass one-half of the PMF, without overtopping the dam. The spillways should also be protected to prevent excessive erosion during the occurrence of one-half of the PMF.

2. Increase the height of the dam in order to pass one-half of the PMF without overtopping the dam; an investigation should also include studying the effects that increasing the height of the dam would have on the structural stability of the present embankment. The overtopping depth during the occurrence of one-half of the PMF, stated in Section 5.1d, is not the required or recommended increase in the height of the dam.

3. A combination of 1 and 2 above.

b. O & M Procedures

1. The seepage observed downstream of the dam should be investigated further by a qualified professional engineer to determine the seriousness and source of the seepage. Proper repairs should be made as required.

2. The corroded principal spillway pipes should be replaced. The undermined areas around the pipes should be repaired and protected from future damage.

3. The erosion in the spillway discharge channel should be repaired and the channel stabilized to resist erosion caused by discharges through the spillway.

4. Either the obstructions of the emergency spillway should be removed or the alignment of the invert of the spillway should be changed. This should be done under the direction of a registered engineer experienced in the design and construction of earth dams.

5. The wave erosion on the upstream slope should be monitored, and, if the erosion continues, protective measures should be employed to protect the slope from further damage.

6. The vegetation on the embankment slopes, especially on the downstream slope, should be properly maintained and an adequate vegetative cover retained to protect the slopes from surface runoff erosion and to prevent excessive erosion in the event the dam is overtopped. Large vegetation, such as bushes and trees, should be prevented from growing on the embankment.

7. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.

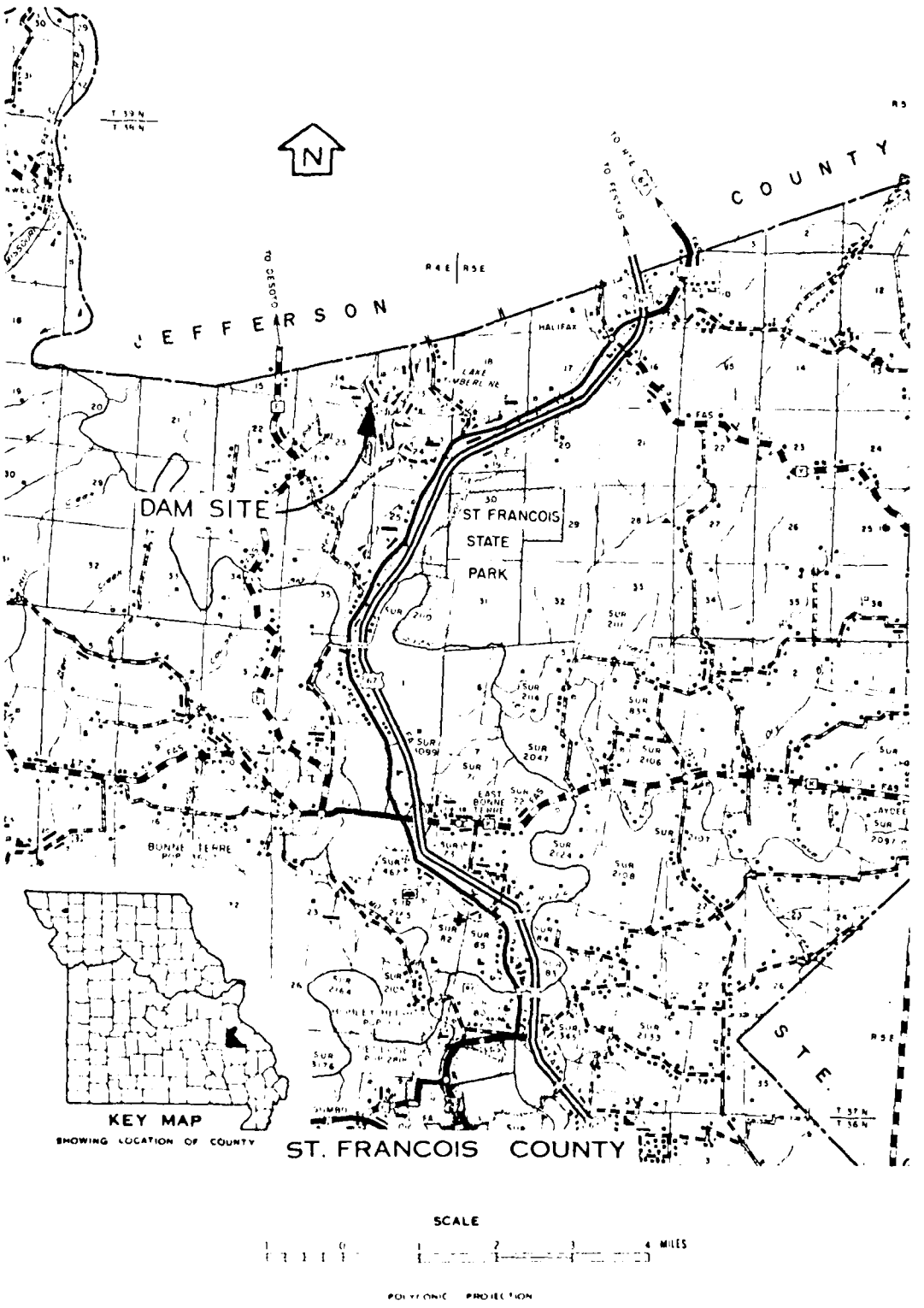
8. The owner should initiate the following programs:

   (a) Periodic inspection of the dam by a professional engineer experienced in the design and construction of earth dams.

   (b) Set up a maintenance schedule and log all repairs, and maintenance.

PLATES

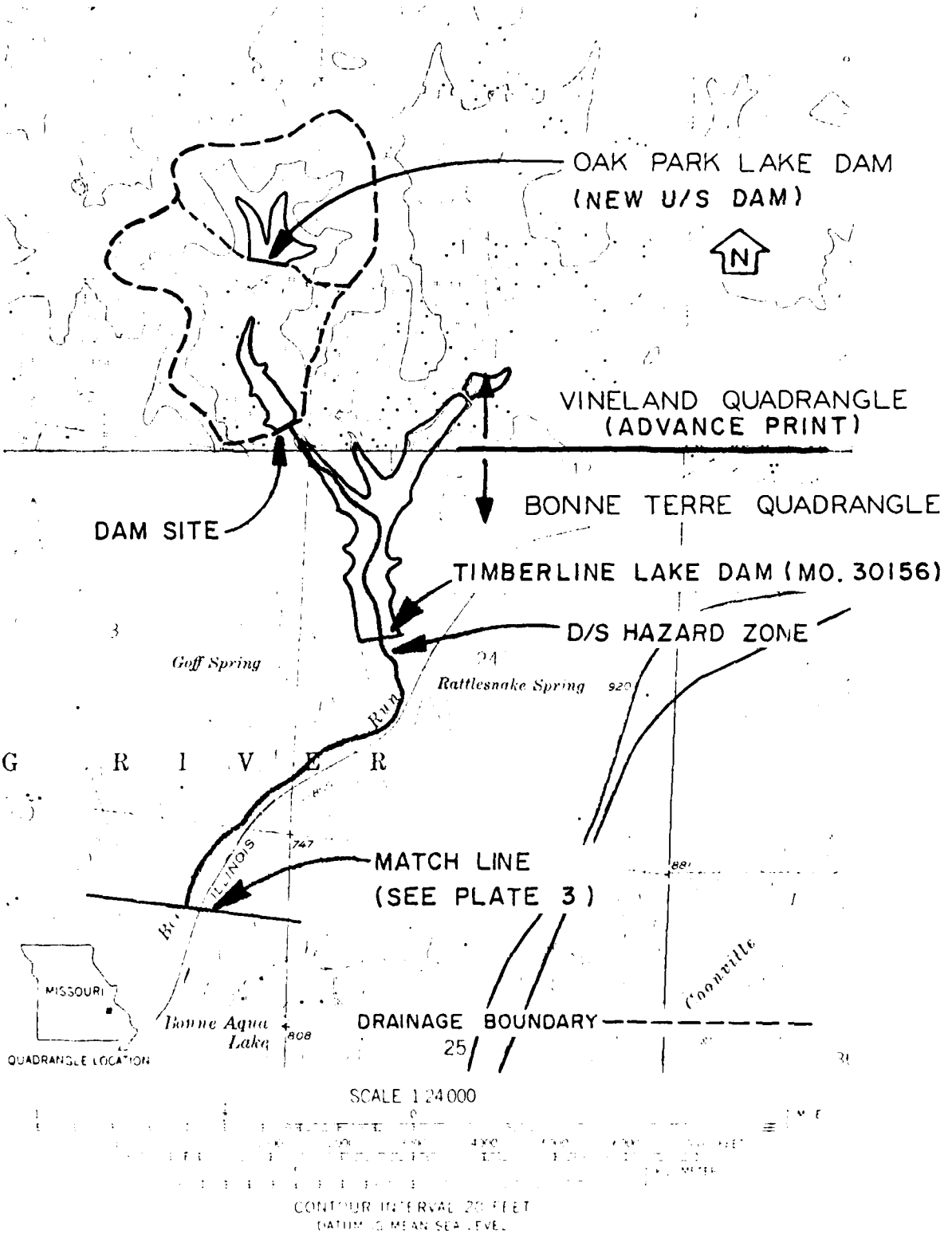
PLATE 1



LOCATION MAP – WAHOO LAKE DAM

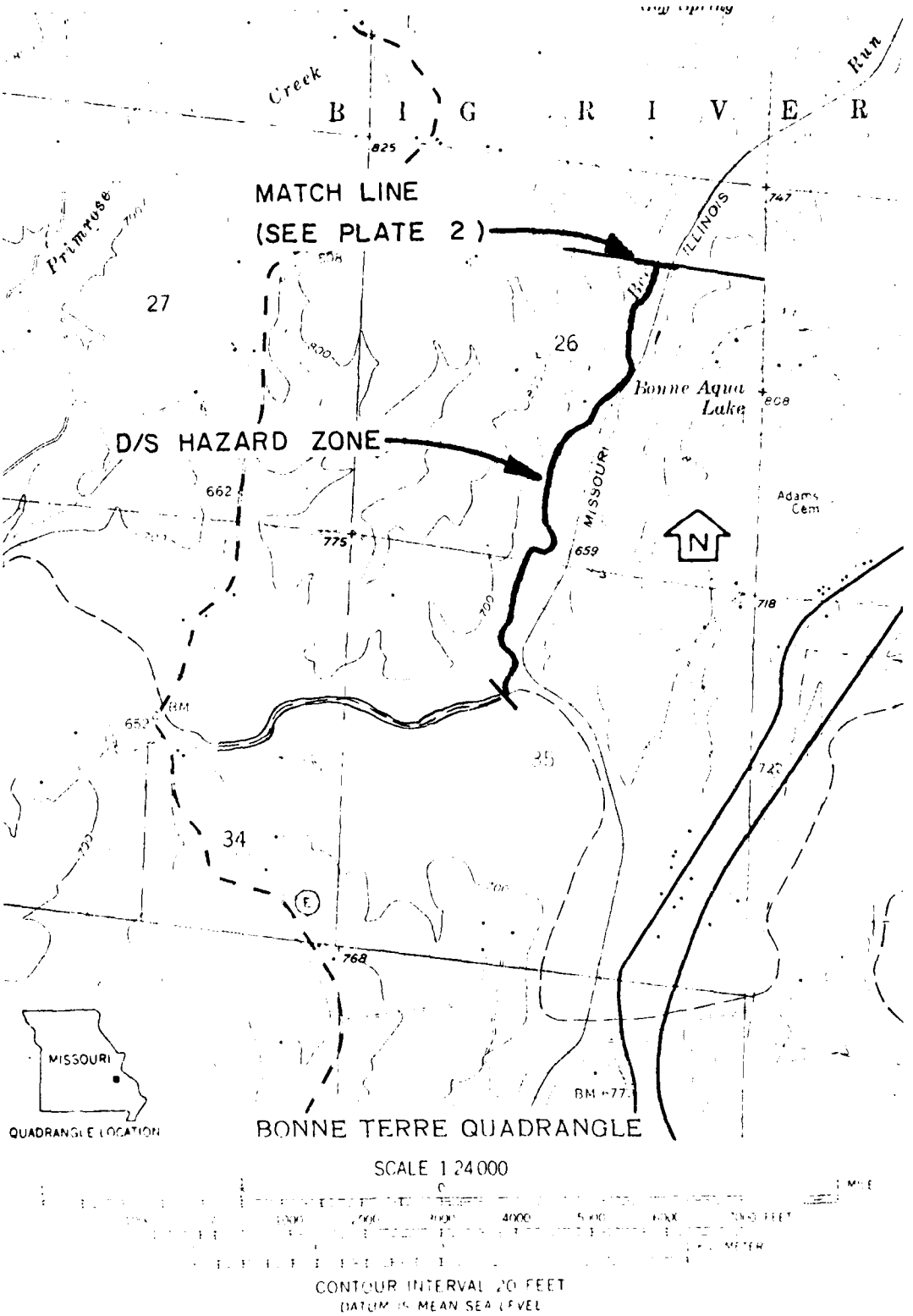
MO. 30155

PLATE 2



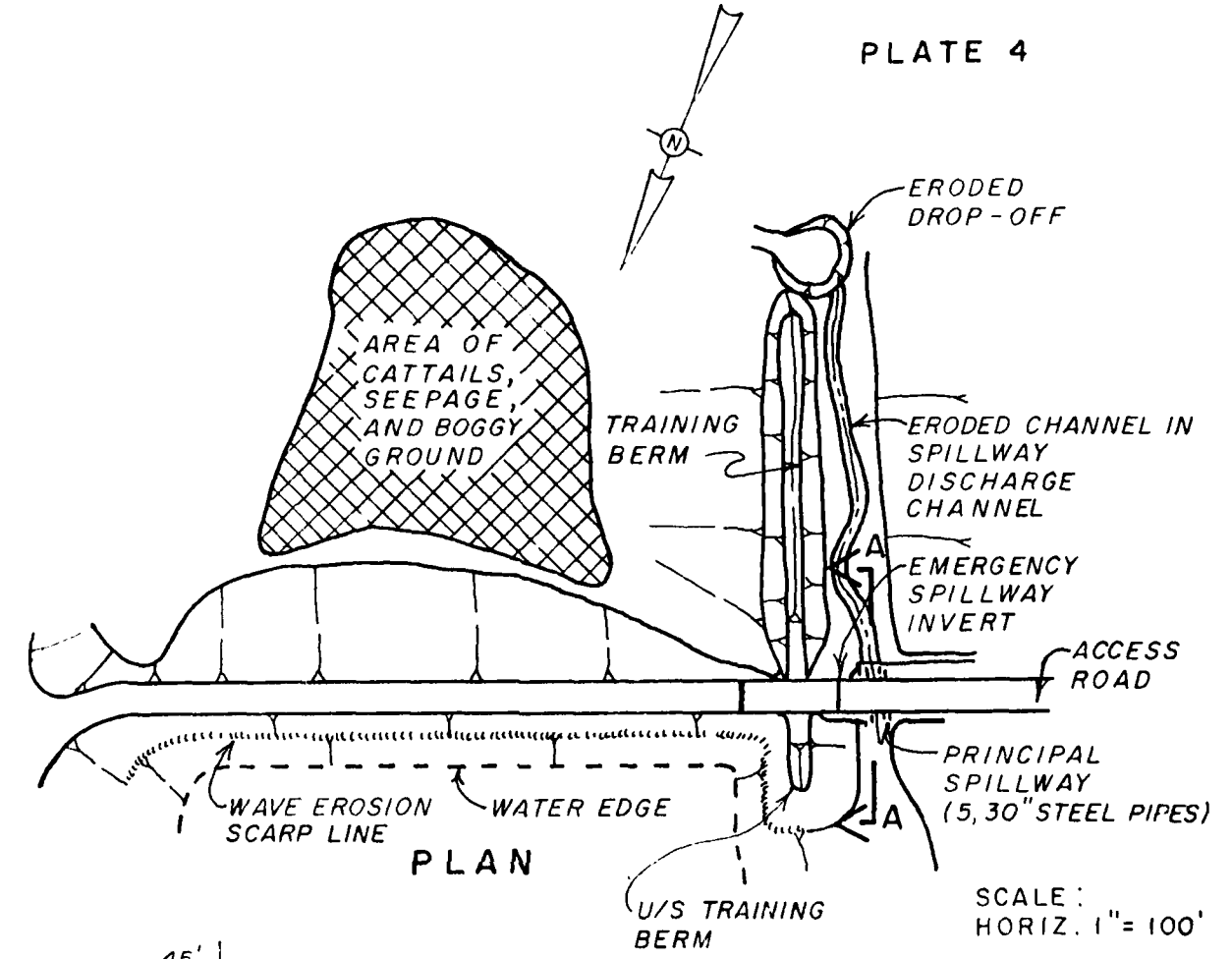
WAHOO LAKE DAM (MO. 30155)

DRAINAGE BASIN AND
DOWNSTREAM HAZARD ZONE
(SHEET 1 OF 2)



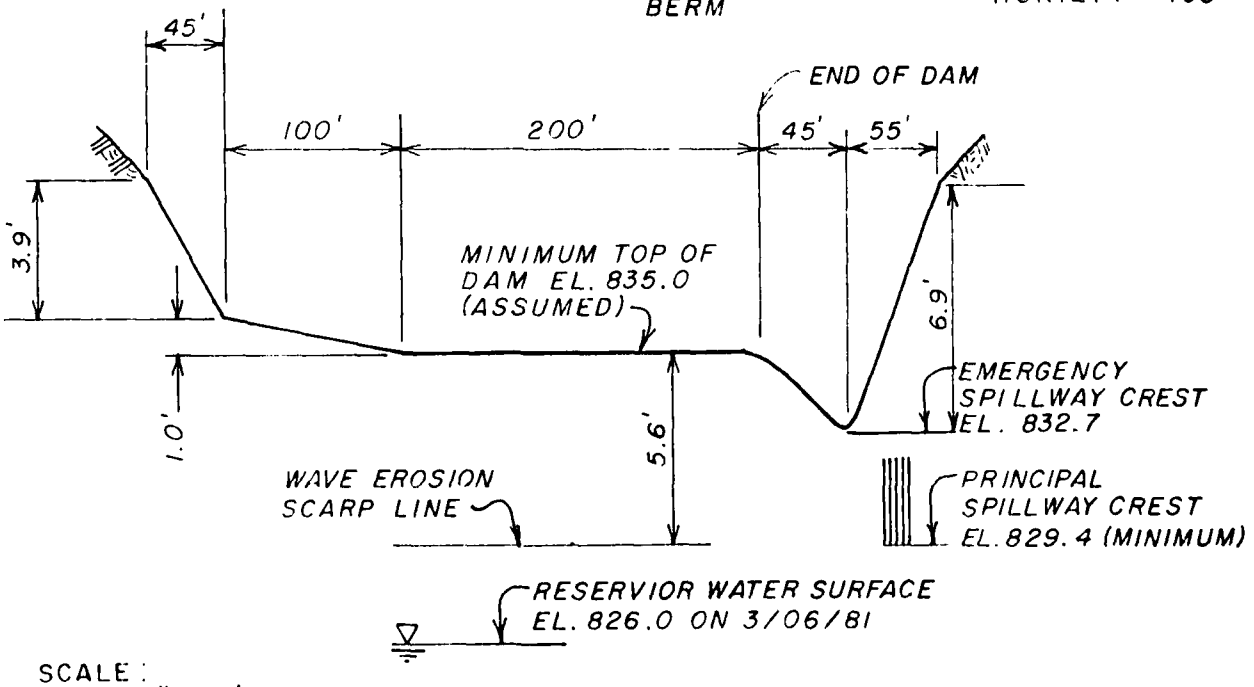
WAHOO LAKE DAM (MO. 30155)
DRAINAGE BASIN AND
DOWNSTREAM HAZARD ZONE
(SHEET 2 OF 2)

PLATE 4



PLAN

SCALE : HORIZ. 1" = 100'

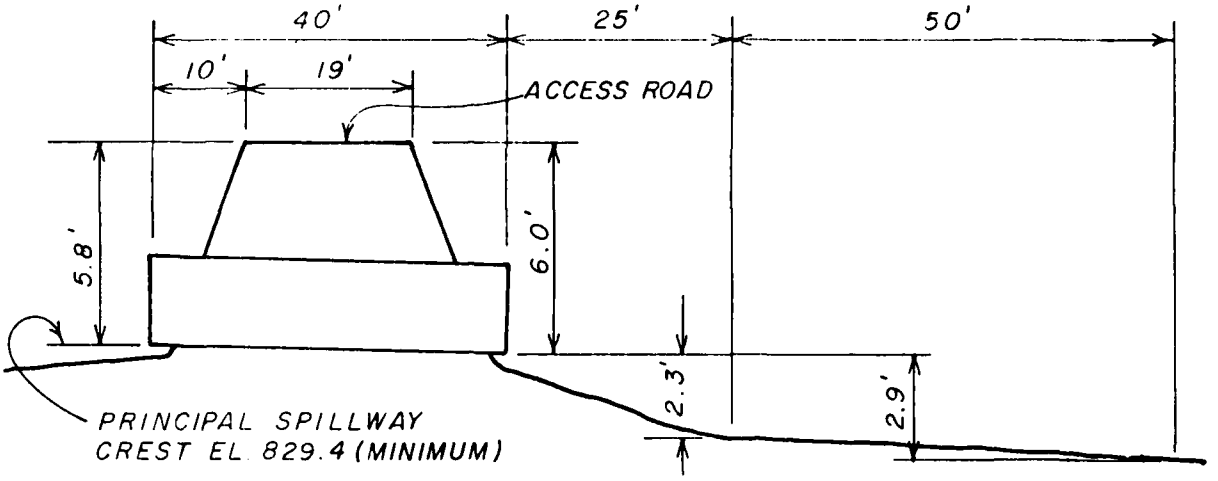


SCALE :
HORIZ. 1" = 100'
VERT. 1" = 5'

ELEVATION

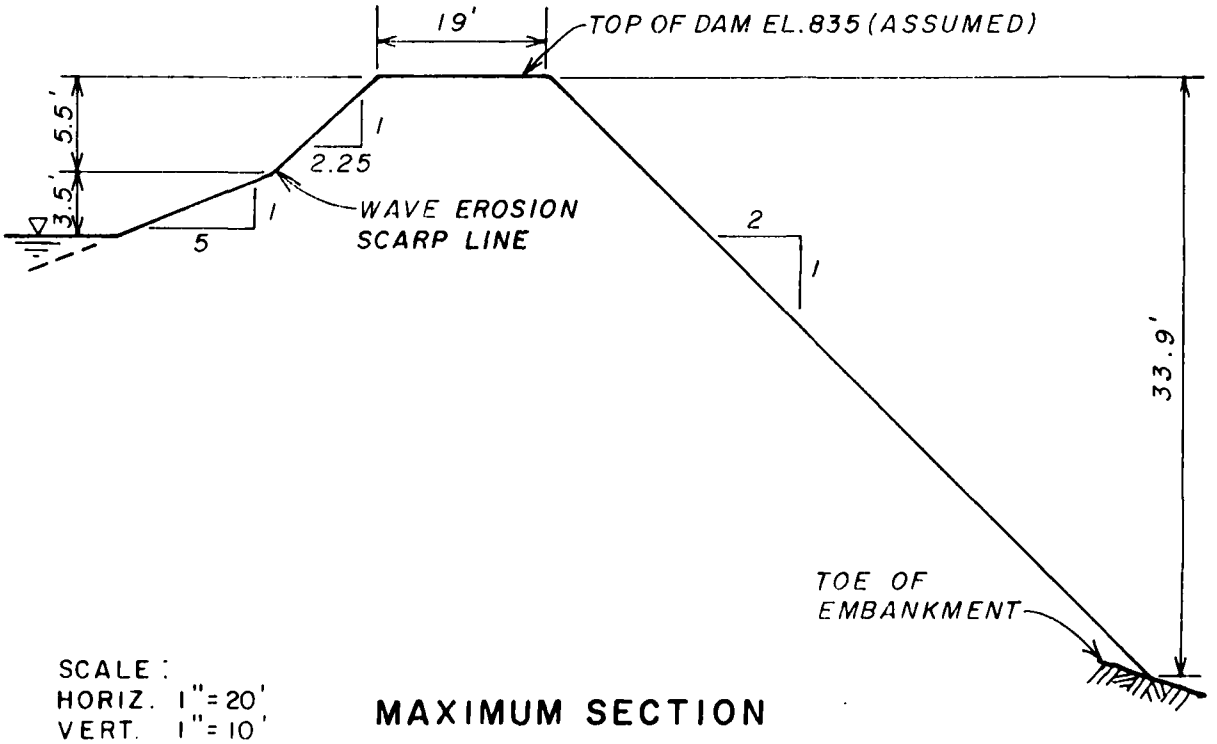
WAHOO LAKE DAM (MO. 30155)
PLAN AND ELEVATION
(SHEET 1 OF 2)

PLATE 5



SCALE:
HORIZ. 1" = 20'
VERT. 1" = 5'

SECTION A-A
(SPILLWAY PROFILE)

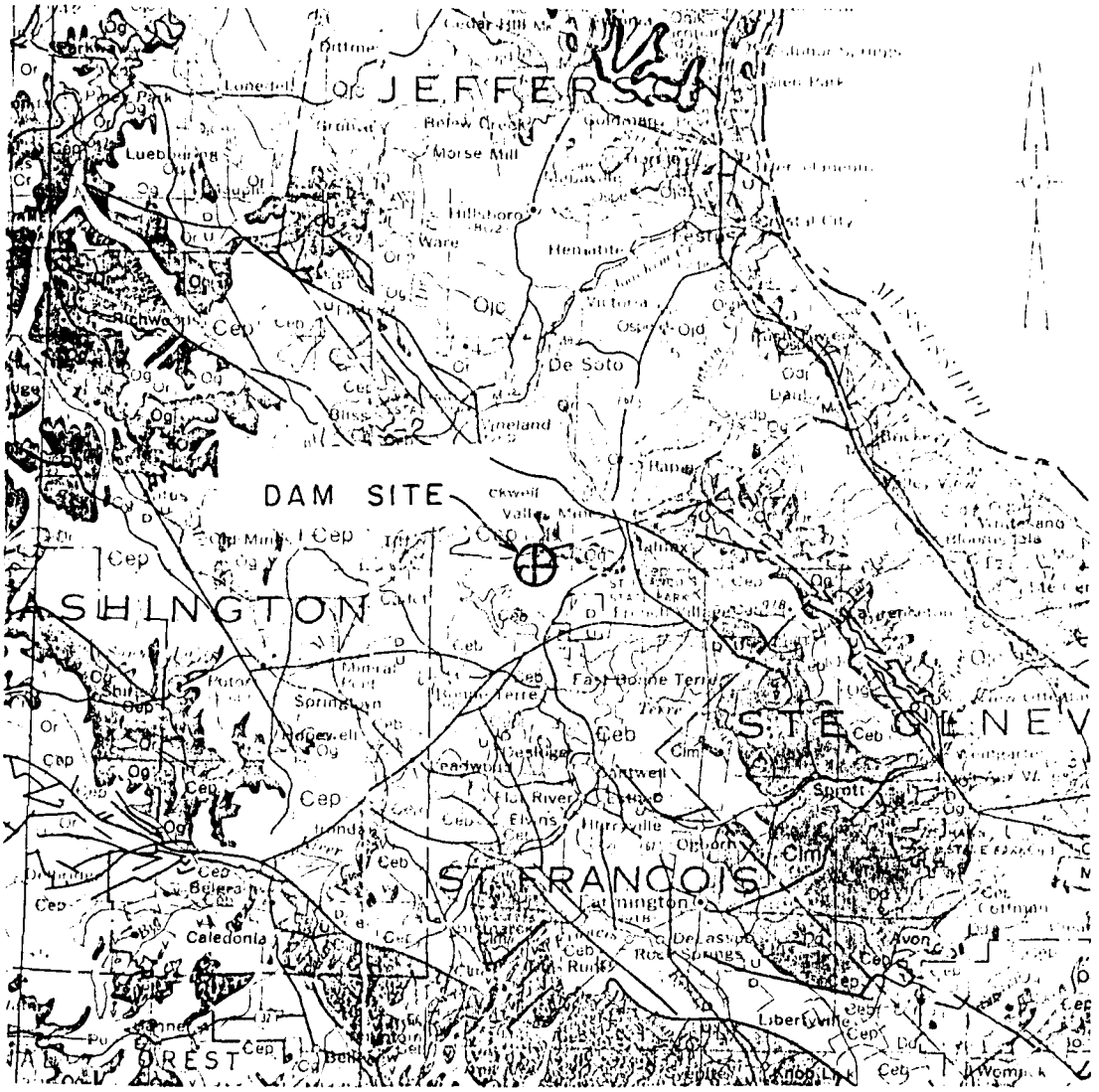


SCALE:
HORIZ. 1" = 20'
VERT. 1" = 10'

MAXIMUM SECTION

WAHOO LAKE DAM (MO. 30155)
SPILLWAY PROFILE AND MAXIMUM SECTION
(SHEET 2 OF 2)

PLATE 6



SCALE

10 0 10 20 30 40 Miles

⊕ LOCATION OF DAM

NOTE: LEGEND FOR THIS MAP IS ON PLATES 7 AND 8.

REFERENCE:

GEOLOGIC MAP OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
MISSOURI GEOLOGICAL SURVEY
KENNETH H. ANDERSON, 1979

REGIONAL GEOLOGICAL MAP OF WAHOO LAKE DAM

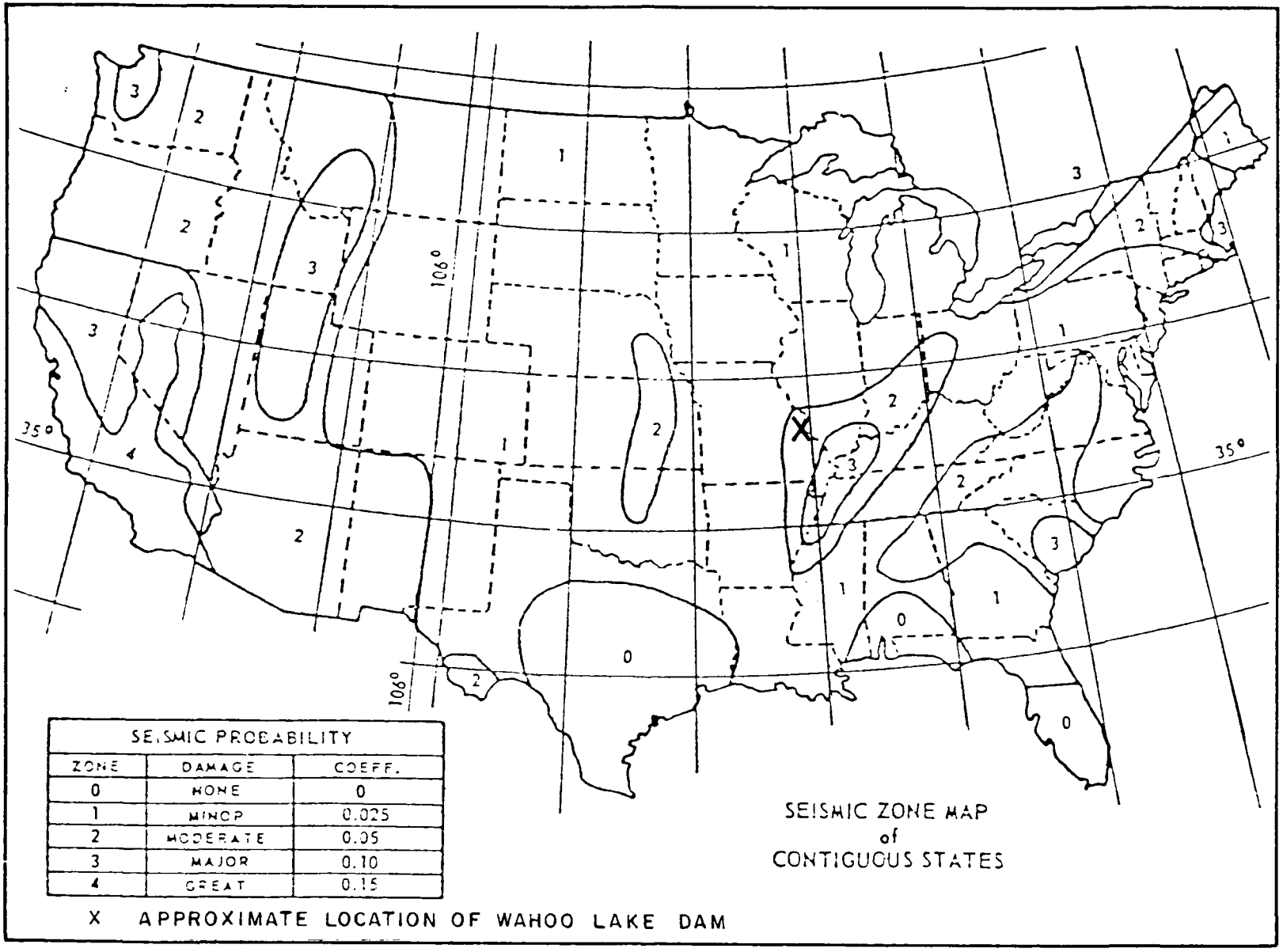
LEGEND

PERIOD	SYMBOL	DESCRIPTION
QUATERNARY	Qal	ALLUVIUM: SAND, SILT, GRAVEL
MISSISSIPPIAN	Mo	KEOKUK – BURLINGTON FORMATION: CHERTY GRAYISH BROWN SANDY LIMESTONE
	Mk	UNDIFFERENTIATED CHOUTEAU GROUP: LIMESTONE
	Mk	HANNIBAL FORMATION: SHALE AND SILTSTONE
DEVONIAN	Dd	DIATREMES, KIMBERLITES, CARBONATITES
ORDOVICIAN	Omk	MAQUOKETA SHALE, KIMMSWICK LIMESTONE
	Odp	DECORAH FORMATION: GREEN TO GRAY CALCAREOUS SHALE WITH THIN FOSSILIFEROUS LIMESTONE
	Ospe	ST. PETER SANDSTONE, EVERTON FORMATION
	Ojd	JOACHIM DOLOMITE
	Ojc	POWELL DOLOMITE, COTTER DOLOMITE
	Or	ROUBIDOUX FORMATION: INTERBEDS OF CHERTY LIMESTONE AND SANDSTONE
	Og	GASCONADE DOLOMITE

WAHOO LAKE DAM
PLATE 8
SHEET 2 OF 2

LEGEND

PERIOD	SYMBOL	DESCRIPTION
CAMBRIAN	ϵep	EMINENCE DOLOMITE, POTOSI DOLOMITE
	ϵeb	FRANCONIA AND BONNETERRE FORMATION: INTERBEDDED LIMESTONE, CHERTY LIMESTONE, DOLOMITE AND SILTSTONE
	ϵlm	LAMOTTE SANDSTONE
PRECAMBRIAN	i	ST. FRANCOIS MOUNTAINS INTRUSIVE
	V	ST FRANCOIS MOUNTAINS VOLCANIC
	U / D	NORMAL FAULT
	U / D	INFERRED FAULT
	U =	UPTHROWN SIDE; D = DOWNTHROWN SIDE



SEISMIC PROBABILITY		
ZONE	DAMAGE	COEFF.
0	NONE	0
1	MINOR	0.025
2	MODERATE	0.05
3	MAJOR	0.10
4	GREAT	0.15

X APPROXIMATE LOCATION OF WAHOO LAKE DAM

PLATE 9

APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

PHOTO INDEX
FOR
WAHOO LAKE DAM

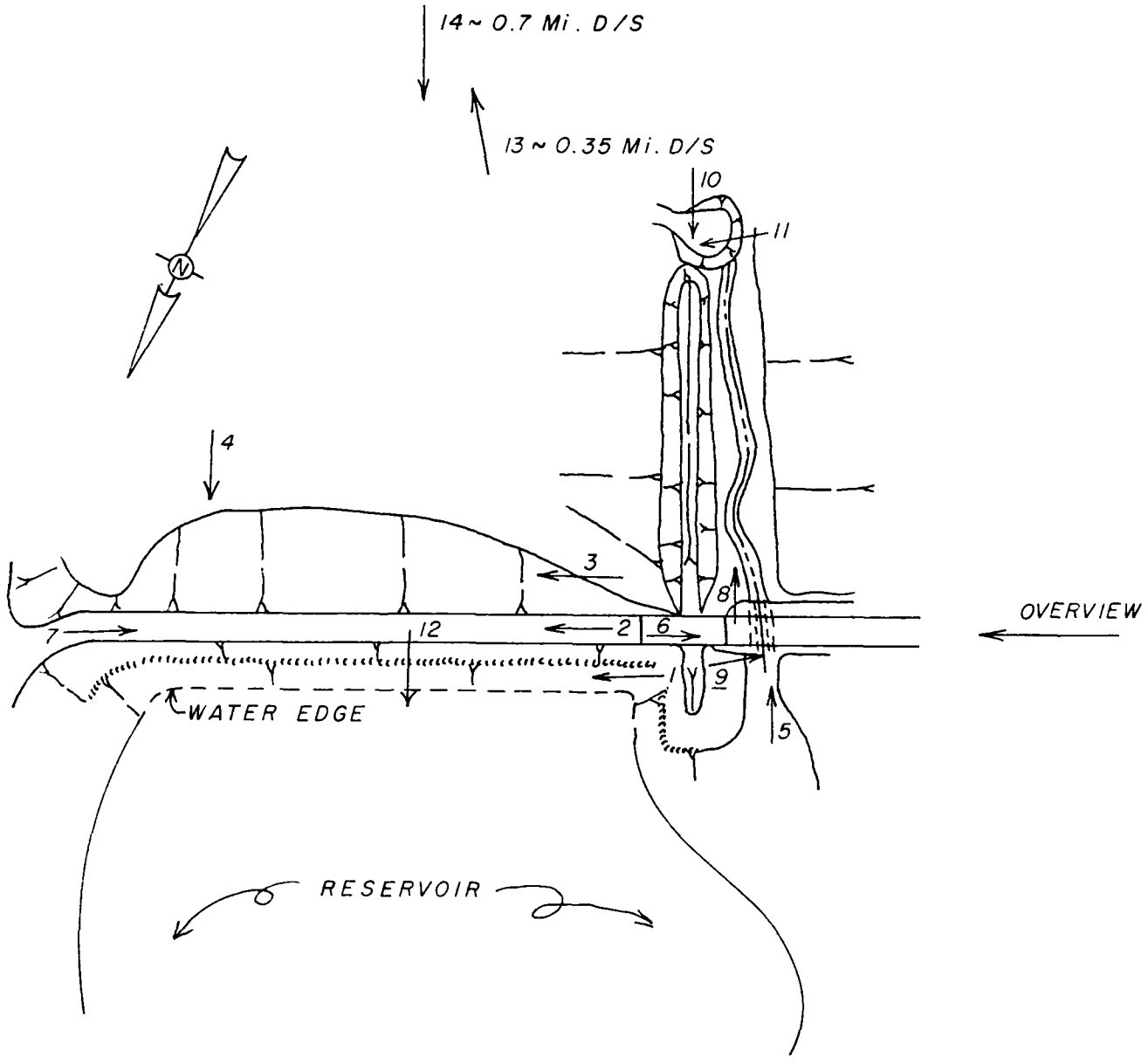


Photo 1 - View of the upstream slope from the right abutment.

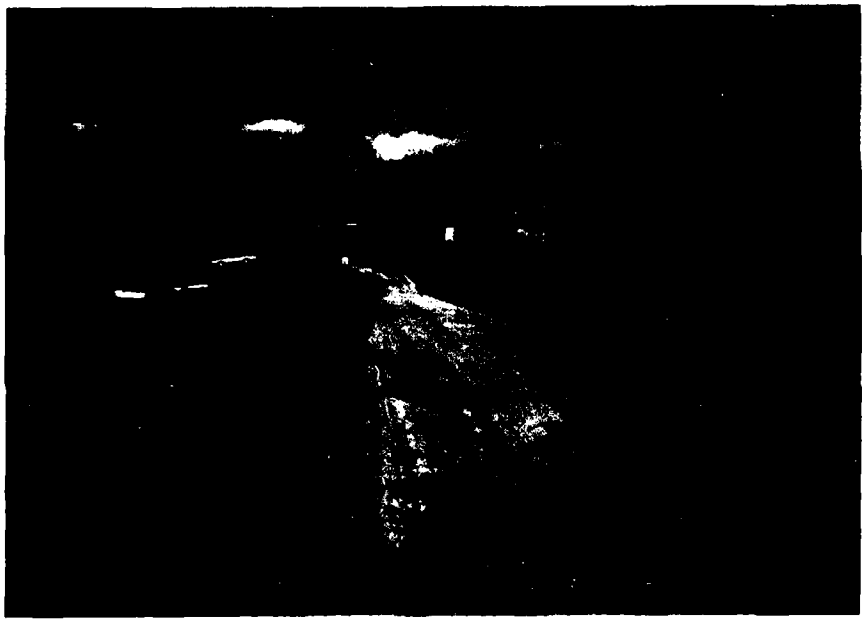


Photo 2 - View of the top of dam from the right abutment.

Photo 3 - View of the downstream slope from the right abutment.

Photo 4 - Close-up view of one area of flowing seepage looking upstream toward the toe of the dam.

Photo 5 - View of the principal spillway pipe inlets and the access road taken from the reservoir.

Photo 6 - View of the emergency spillway broad-crested weir formed by the access road over the principal spillway pipes and the top of dam. Note the erosion gullies along the access road in the background.

Photo 7 - View of the spillway training berms (in the background) taken from the left abutment.

Photo 8 - View of the eroded spillway discharge channel taken from the access road with the training berm shown on the left. Note the end of the channel in the background.

Photo 9 - Close-up view of the corroded inlets and undermining of the principal spillway pipes.

Photo 10 - View of the eroded dropoff at the end of the spillway discharge channel. Note the exposure of highly weathered dolomite.

Photo 11 - Close-up view of the highly weathered dolomite with secondary sedimentary structures in the eroded dropoff of the spillway discharge channel.

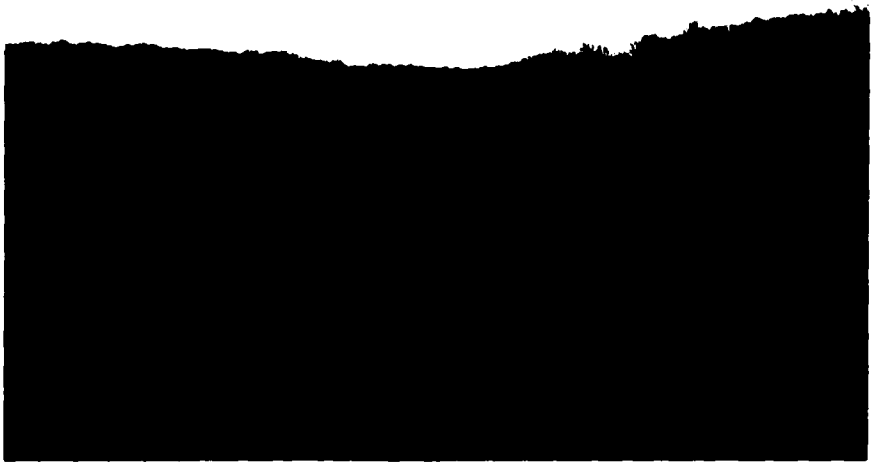


Photo 12 - View of the reservoir and rim.

Photo 13 - View of some dwellings looking across Lake Timberline, which shows one dwelling that is believed to be in the downstream hazard zone and Timberline Lake Dam in the background.

Photo 14 - View of a clubhouse in the downstream hazard zone looking across Bee Run Creek.

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

WAHOO LAKE DAM

HYDROLOGIC AND HYDRAULIC DATA, ASSUMPTIONS AND METHODOLOGY

1. SCS Unit Hydrograph procedures and the HEC-1DB computer program are used to develop the inflow hydrographs. The hydrologic inputs are as follows:

   (a) 24-hour Probable Maximum Precipitation from the Hydrometeorological Report No. 33, and 24-hour 100-year rainfall and 24-hour 10-year rainfall of Ste. Genevieve, Missouri.

   (b) Drainage area = 0.38 square miles (including area above U/S dam).

   (c) Lag time = 0.12 hours.

   (d) Hydrologic Soil Group:
   Soil Group "C".

   (e) Runoff curve number:
   CN = 73 for AMC II and CN = 87 for AMC III.

2. Flows rates through the principal spillway are based on calculating discharges for different flow regimes and determining which regime controls. Flow rates through the emergency spillway are based on HEC-2 generated profiles assuming critical depth at the drop-off at the downstream end of the spillway discharge channel and a Manning's n = 0.030. Flow rates over the dam are based on the broad-crested weir equation $Q = CLH^{3/2}$ and critical depth assumption, in accordance with the procedures used in the HEC-1 computer program.

3. The principal and emergency spillways and the dam overtop rating curves are hand calculated and combined as shown on pages B-5 through B-16. This combined rating curve is input into HEC-1DB on the Y4 and Y5 cards. The $L and $V cards are, therefore, not used.

4. Floods are routed through Wahoo Lake to determine the capability of the spillways. The analysis of Wahoo Lake Dam included the hypothetical breach of the upstream dam for those floods during which the upstream dam was overtopped.

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. ___ OF ___

DAM NAME: Wahoo Lake Dam (MO. 30155) — JOB NO. 1283

UNIT HYDROGRAPH PARAMETERS — BY VFK — DATE 4/17/81

1) DRAINAGE AREA, $A = 0.21$ sq. mi = (134. acres)

2) LENGTH OF STREAM, $L = (1.4 \text{ "} \times 2000' = 2,800') = 0.53$ mi.

3) ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM,

$H_1 = 945$

4) ELEVATION OF RESERVOIR AT SPILLWAY CREST, $H_2 = 829.4$

5) ELEVATION OF CHANNEL BED AT 0.85L, $E_{85} = 920$

6) ELEVATION OF CHANNEL BED AT 0.10L, $E_{10} = 835$

7) AVERAGE SLOPE OF THE CHANNEL, $S_{AVG} = (E_{85} - E_{10})/0.75L = 0.04$

8) TIME OF CONCENTRATION:

A) BY KIRPICH'S EQUATION,

$t_c = [(11.9 \times L^3)/(H_1 - H_2)]^{0.385} = [11.9 \times (0.53)^3/(945 - 829.4)]^{0.385} = 0.20$ hrs

B) BY VELOCITY ESTIMATE,

SLOPE = 4% $\Rightarrow$ AVG. VELOCITY = 3 fps

$t_c = L/V = 2800'/3 \text{ fps} \times 1/3600 \text{ s/hr} = 0.26$ hrs

USE $t_c = 0.20$ hrs

9) LAG TIME, $t_l = 0.6\, t_c = 0.12$ hrs.

10) UNIT DURATION, $D \leq t_l/3 = 0.04$ < 0.083 hr.

USE $D = 0.083$

11) TIME TO PEAK, $T_p = D/2 + t_l = 0.083/2 + 0.12 = 0.16$ hrs.

12) PEAK DISCHARGE,

$q_p = (484 \times A)/T_p = (484 \times 0.21)/0.16 = 635$ cfs

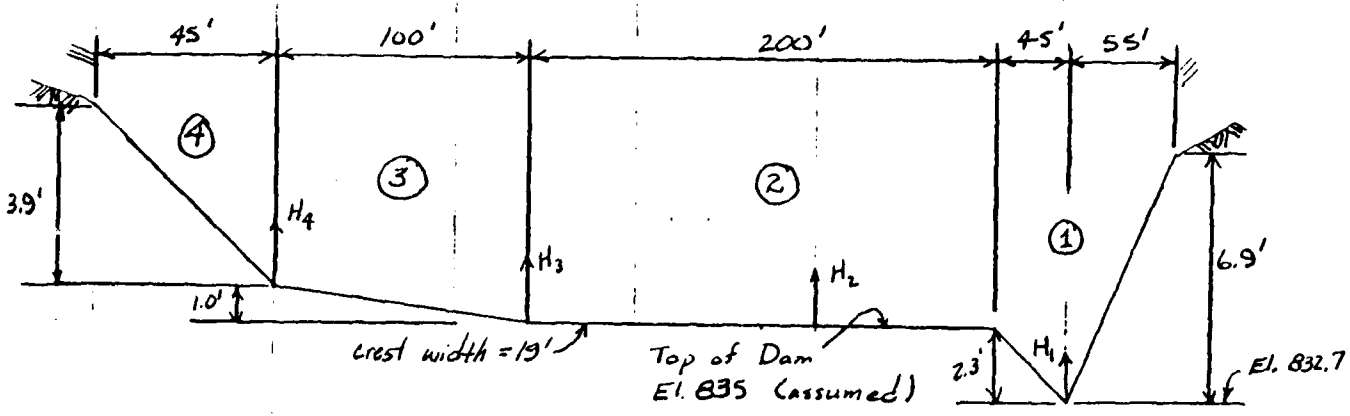
ECI-4 PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection - Missouri SHEET NO. ____ OF ____

Wahoo Lake Dam (MO. 30155) JOB NO. 1283

Reservoir Elevation - Area Data BY JFK DATE 4/20/81

Elev., MSL (ft)	Area (acres)	Remarks
805	0	Estimated streambed U/S of Dam
815	3.0	Interpolated
825	9.0	"
829.4	12.0	Principal Spillway Crest
832.7	14.5	Emergency Spillway Crest
835	16.5	Minimum Top of Dam (assumed)
840	21.0	Measured from Vineland 7.5' USGS Quad
850	31.0	Interpolated
860	41.5	Measured from Vineland 7.5' USGS Quad



Section 1: for $0 < y_1 \leq 2.3$: $A_1 = 13.8 y_1^2$, $T_1 = 27.5 y_1$; for $2.3 < y_1 \leq 6.9$: $A_1 = 51.8 + 45 y_1 + 4. y_1^2$, $T_1 = 45. + 8. y_1$; $y_1 = H_1 - V_1^2/2g$

NOTE: A backwater profile in the discharge channel and the emergency spillway was calculated using HEC-2. Critical depth occurs at the downstream edge of the spillway. H_1 is based on the water surface elevation at the upstream edge of the spillway.

Section 2: H_2 = W.S.EL - 835.
$Q_2 = C_L L H_2^{1.5}$

Section 3: for $y_3 \leq 1.0$: $y_3 = 4/5\, H_3$, $A_3 = 50. y_3^2$, $T_3 = 100\, y_3$; for $y_3 > 1.0$: $y_3 = 2/3 (H_3 + 0.25)$, $A_3 = 100. y_3 - 50.$, $T_3 = 100.$; $Q = \sqrt{A_3^3 g / T_3}$

Section 4: for $y_4 \leq 3.9$: $y_4 = 4/5\, H_4$, $A_4 = 5.8\, y_4^2$, $T_4 = 11.5\, y_4$; for $y_4 > 3.9$: $y_4 = 2/3 (H_4 + 0.98)$, $A_4 = 45. y_4 - 87.8$, $T_4 = 45.$; $Q = \sqrt{A_3^3 / T_3}$

PRC ENGINEERING CONSULTANTS, INC.

Missouri Dam Safety Inspection — SHEET NO. — OF

Wahoo Lake Dam (MO. 30155) — JOB NO. 1283

Spillway and Overtop Rating Curve — BY JFK — DATE 4/20/81

← Refer to HEC-2 Printout, SECNO 8 →

W.S. EL.	Y_1	A_1	T_1	V_1	$V_1^2/2g$	Q_1	H_2	C_2	Q_2	H_3	Y_3	A_3	T_3	Q_3	H_4	Y_4	A_4	T_4	Q_T
832.7	0	0	0	0	0	0													
833.4	.66	6.2	18.5	1.6	.04	10													
833.7	.92	11.7	25.4	2.1	.07	25													
834.0	1.18	19.3	32.6	2.6	.10	50													
834.2	1.37	26.1	37.9	2.9	.13	75													
834.4	1.52	31.8	41.9	3.1	.15	100													
834.7	1.76	42.7	48.5	3.5	.19	150													
834.9	1.96	52.7	53.9	3.8	.22	200	0	0	0	0	0	0	0	0					
835.1	2.13	62.1	58.5	4.0	.25	250	0.1	2.93	18.5	0.1	.08	0.3	8.	0.4					
835.3	2.28	70.8	62.4	4.2	.28	300	0.3	2.99	98.3	0.3	.24	2.9	24.	5.7					
835.6	2.52	86.3	65.0	4.6	.33	400	0.6	3.02	280.7	0.6	.48	11.5	48.	32.0					
835.8	2.73	100.7	66.6	5.0	.38	500	0.8	3.03	433.6	0.8	.64	20.5	64.	45.7	0	0	0	0	0
836.4	3.17	130.6	70.2	5.7	.51	750	1.4	3.04	1007.2	1.4	1.10	60.0	100.	263.7	0.4	0.32	0.6	3.7	1.3
836.9	3.54	157.1	73.2	6.4	.63	1000	1.9	3.04	1592.3	1.9	1.43	93.3	100.	511.7	0.9	0.72	3.0	8.3	10.2
837.3	3.91	185.1	76.2	6.8	.71	1250	2.3	3.05	2127.8	2.3	1.70	120.0	100.	745.9	1.3	1.04	6.2	12.0	25.5

W.S EL.	Q_{TOTAL}
832.7	0
833.4	10
833.7	25
834.0	50
834.2	75
834.4	100
834.7	150
834.9	200
835.1	269
835.3	404
835.6	713
835.8	999.
836.4	2022.
836.9	3114
837.3	4149

HEC-2 INPUT AND SUMMARY TABLE

WSEL FQ

0.000

CHNIM ITRACE

0.000 0.000

17.000

0.000

0.000 0.000 0.000
0.000 0.000 0.000
0.000 0.000 0.000

-2.280 0.000
836.900 61.000

.400 0.000

.600 0.000

.600 0.000

.600 0.000

[illegible]

[illegible] INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

[illegible]	[illegible]	[illegible]	[illegible]	VC	PV	G	FG	10K*S	K*XNCH
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	825.67	195.11	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.51	[illegible]	827.14	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50.00	[illegible]	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.47	75.00	[illegible]	141.68	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100.00	827.27	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	150.00	827.72	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	200.00	828.04	131.68	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.64	[illegible]	[illegible]	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.73	300.00	[illegible]	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	7.41	[illegible]	400.00	[illegible]	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.97	500.00	829.59	118.03	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	750.00	[illegible]	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	830.96	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	97.53	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.21	[illegible]	[illegible]	97.89	30.00
[illegible]	1.7	[illegible]	[illegible]	[illegible]	.31	[illegible]	[illegible]	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	827.47	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.44	[illegible]	[illegible]	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	828.21	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	200.00	[illegible]	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	250.00	[illegible]	111.44	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	300.00	[illegible]	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	450.00	[illegible]	[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	500.00	829.87	113.84	30.00
[illegible]	[illegible]	[illegible]	[illegible]	.77	[illegible]	750.00	830.73	107.05	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1000.00	831.96	101.33	30.00
[illegible]	[illegible]	[illegible]	51.11	[illegible]	[illegible]	1250.00	832.10	98.32	30.00

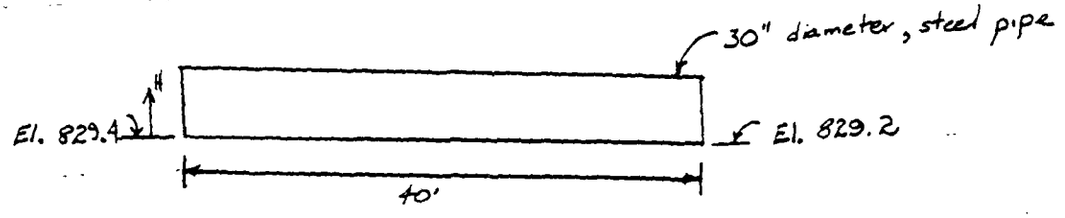
[illegible]	[illegible]	[illegible]	[illegible]	VEH	HV	G	FG	10K•S	K•XNCH
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.16	10.00	826.77	131.[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.[illegible]	[illegible]	[illegible]7.22	12[illegible].44	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.36	[illegible]	[illegible]7.72	126.01	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.45	75.00	828.07	126.04	30.00
[illegible]	[illegible]	[illegible]	[illegible]	5.66	.[illegible]	100.00	828.36	12[illegible].46	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.[illegible]1	1[illegible].00	828.80	12[illegible].72	30.00
[illegible]	[illegible]	[illegible]	[illegible]	5.91	.64	200.00	829.12	12[illegible].44	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible].51	.[illegible]	[illegible].00	8[illegible].39	12[illegible].[illegible]2	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.69	300.00	829.64	116.71	30.00
[illegible]	[illegible]	[illegible]	[illegible]	7.45	.65	400.00	830.36	11[illegible].26	30.00
[illegible]	[illegible]	[illegible]	[illegible]	7.57	.[illegible]	[illegible].00	830.47	114.[illegible]3	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.19	7[illegible].00	831.53	106.49	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.[illegible]	1000.00	8[illegible]2.0[illegible]	101.79	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.[illegible]	1[illegible].00	832.70	[illegible].37	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.14	10.00	827.37	110.53	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.[illegible]	2[illegible].00	827.84	114.97	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.33	[illegible].00	828.52	117.42	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.40	75.00	828.67	114.38	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.57	100.00	[illegible].96	115.[illegible]1	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.[illegible]	150.00	[illegible]9.41	11[illegible].41	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.[illegible]	200.00	8[illegible].73	119.94	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible].51	.[illegible]	2[illegible].00	8[illegible].99	12[illegible].01	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible].74	.70	300.00	830.23	12[illegible].[illegible]	30.00
[illegible]	[illegible]	[illegible]	[illegible]	7.45	.[illegible]5	4[illegible].00	[illegible]	11[illegible].19	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.[illegible]	500.00	831.07	114.36	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.1[illegible]	751.00	831.9[illegible]	10[illegible].67	30.00
[illegible]	[illegible]	[illegible]	[illegible]	9.[illegible]	1.58	1000.00	832.66	101.64	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.[illegible]5	1[illegible].00	833.30	[illegible].15	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.16	1[illegible].00	[illegible]7.97	127.44	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.24	25.00	8[illegible].[illegible]	11[illegible].10	30.00
[illegible]	[illegible]	[illegible]	[illegible]	4.73	.[illegible]	50.00	[illegible].91	122.35	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.4[illegible]	75.00	829.[illegible]7	121.21	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.4[illegible]	100.00	[illegible]	120.85	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible].65	.49	151.00	830.00	117.12	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible].77	.[illegible]	[illegible].00	830.32	116.00	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.[illegible]	2[illegible].00	8[illegible]	11[illegible].98	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.71	300.00	830.84	121.33	30.00
[illegible]	[illegible]	[illegible]	[illegible]	7.[illegible]	.[illegible]	401.00	831.28	119.22	30.00
[illegible]	[illegible]	[illegible]	[illegible]	7.[illegible]	.[illegible]	5[illegible].00	831.67	114.46	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible].76	1.19	7[illegible].00	832.[illegible]	10[illegible].61	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.[illegible]	1000.00	[illegible]33.26	101.69	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.[illegible]	1[illegible].00	[illegible]33.90	98.12	30.00

[illegible]	T	[illegible]	[illegible]	VCH	HV	G	EG	16K*S	K*XNCH
[illegible]	[illegible]	[illegible]	[illegible]	5.75	.22	10.00	830.25	189.92	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.31	25.00	850.72	16?.38	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.4?	50.00	851.21	14?.08	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.47	75.00	851.56	142.96	30.00
[illegible]	[illegible]	17.12	[illegible]	[illegible]	.5?	100.00	851.85	13?.30	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.5?	150.00	852.30	13?.11	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.57	200.00	852.62	130.88	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.67	250.00	852.89	13?.44	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.7?	300.00	853.14	12?.79	30.00
[illegible]	[illegible]	[illegible]	[illegible]	7.46	.85	400.00	853.58	11?.21	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.?6	500.00	853.97	114.42	30.00
[illegible]	[illegible]	[illegible]	[illegible]	4.76	1.19	750.00	854.83	10?.63	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.3?	1000.00	855.56	101.67	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.5?	1250.00	856.20	9?.13	30.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.15	10.00	8?5.33	9?.71	20.00
[illegible]	[illegible]	[illegible]	[illegible]	5.47	.19	25.00	853.61	84.69	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.2?	50.00	853.?0	77.18	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.2?	75.00	8?4.11	7?.12	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.22	100.00	834.28	7?.35	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	150.00	8?4.5?	6?.55	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.4?	200.00	834.79	69.05	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.47	250.00	834.99	62.30	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.50	300.00	835.16	60.80	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.56	400.00	835.46	57.80	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.?3	500.00	835.72	56.99	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	750.00	836.??	5?.54	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.?4	1000.00	836.78	4?.44	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.?7	1250.00	837.21	47.??	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.09	10.00	833.40	20.08	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.17	25.00	833.69	23.49	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.19	50.00	833.99	24.49	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.13	75.00	834.20	24.69	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.15	100.00	834.37	25.94	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.19	150.00	834.66	25.53	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.22	200.00	834.65	2?.?4	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.25	250.00	835.08	27.26	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.2?	300.00	835.25	27.64	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.33	400.00	835.55	26.96	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.?6	500.00	835.81	26.14	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.51	750.00	836.38	26.69	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.?3	1000.00	836.87	27.21	20.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.71	1250.00	837.31	27.14	20.00

PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection - Missouri
Wahoo Lake Dam (MO. 30155)
Principal Spillway Rating Curve

1283
JFK 4/21/81



Consider only one conduit;

Low Flow Case; $H/D < 1.2$ (W.S.EL $\leq$ 832.4)

Assume critical critical depth at inlet, use Table B-2, pg. 558, DSD

y_c	$\frac{d}{D}$	$\frac{Q_c}{D^{5/2}}$	Q	$\frac{h_{v_c}}{D}$	h_v	WSEL
0.5	0.20	0.2371	2.0	.0699	0.17	830.1
1.0	0.40	0.9103	4.0	.1497	0.37	830.8
2.0	0.80	3.505	34.6	.4210	1.05	832.5

Check critical depth assumption, use Table B-3, pg. 558, DSD

for $y = 1.0$

$d/D = 0.40$, $\frac{Q n}{d^{8/3} S^{1/2}} = 1.797$

$S_n = [(4)(0.014)/(1)^{8/3}(1.797)]^2 = 0.001$

$S_{bed} = .2'/40' = 0.005$

$S_{bed} > S_{normal}$, critical depth assumption is OK

EC1-4 PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection – Missouri SHEET NO. ____ OF ____

Wanoo Lake Dam (MO. 30155) JOB NO. 1283

Principal Spillway Rating Curve BY JFK DATE 4/21/81

Orifice Flow Case; $H/D > 1.2$

H_o = W.S. EL - 830.65

$Q = CA\sqrt{2gH_o} = 0.6\left(\frac{\pi(2.5)^2}{4}\right)\sqrt{2g}H_o = 23.6\sqrt{H_o}$

W.S EL	H_o	Q
832.5	1.85	32.1
832.7	2.05	33.8
833.4	2.75	39.1
833.7	3.05	41.2
834.0	3.35	43.2
834.2	3.55	44.5
834.4	3.75	45.7
834.7	4.05	47.5
834.9	4.25	48.7
835.1	4.45	49.8
835.3	4.65	50.9
835.6	4.95	52.5
835.8	5.15	69.6
836.4	5.75	56.6
836.9	6.25	59.0
837.3	6.65	60.9

ECI-4 PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection - Missouri — SHEET NO. ____ OF ____
Wahoo Lake Dam (MO. 30155) — JOB NO. 1283
Principal Spillway Rating Curve — BY JFK DATE 4/21/81

Pressure Flow Case ; $H/D > 1.5$

$$H_T = \Sigma K \frac{V^2}{2g}$$

$$V = \sqrt{\frac{2g}{\Sigma K}} H_T$$

$$Q = VA$$

where,

$K_{entrance} = 0.5$

$K_{exit} = 1.0$

$$K_{friction} = 29.16 \frac{n^2 L}{R_h^{4/3}} = 29.16 \frac{(0.014)^2 40}{(1.25/2)^{4/3}} = 0.4$$

$\Sigma K = 1.9$

$Q = 28.6 \sqrt{H_T}$, where H_T = W.S.EL. - T.W.EL.*

* refer to HEC-2 printout @ Section 6 for T.W. EL.

W.S.EL.	T.W.EL.	H_T	Q
833.4	830.3	3.1	50.4
833.7	830.7	3.0	49.5
834.0	831.2	2.8	47.9
834.2	831.6	2.6	46.1
834.4	831.9	2.5	45.2 +
834.7	832.3	2.4	44.3
834.9	832.6	2.3	43.4
835.1	832.9	2.2	42.4
835.3	833.2	2.1	41.4
835.6	833.6	2.0	40.4
835.8	834.0	1.8	38.4
836.4	834.8	1.6	36.2
836.9	835.6	1.3	32.6
837.3	836.2	1.1	30.0

EC1-4 PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection - Missouri SHEET NO. ____ OF ____

Wahoo Lake Dam (MO. 30155) JOB NO. ____

Principal Spillway Rating Curve BY ____ DATE ____

W.S EL.	$Q_{CULVERT}$	Flow Regime	Q_{TOTAL} (5x $Q_{CULVERT}$)
829.4	0		0
830.1	2.0	Low Flow	10
830.8	4.0	" "	20
832.5	32.1	Orifice Flow	160
832.7	33.8	" "	169
833.4	39.1	" "	196
833.7	41.2	" "	206
834.0	43.2	" "	216
834.2	44.5	" "	223
834.4	45.2	Pressure Flow	226
834.7	44.3	" "	222
834.9	43.4	" "	217
835.1	42.4	" "	212
835.3	41.4	" "	207
835.6	40.4	" "	202
835.8	38.4	" "	192
836.4	36.2	" "	181
836.9	32.6	" "	163
837.3	30.0	" "	150

PRC ENGINEERING CONSULTANTS, INC.

Missouri Dam Safety Inspection — SHEET NO ____ OF ____

Wahoo Lake Dam (MO. 30155) — JOB NO 1283

Combined Rating Curve — BY JFK — DATE 4/21/81

W.S. EL.	$Q_{PRINCIPAL\ SPILLWAY}$	$Q_{EM.\ SPLWY\ AND\ OVERTOP}$	Q_{TOTAL}
829.4	0		0
830.1	10		10
830.8	20		20
832.5	160		160
832.7	169	0	169
833.4	196	10	206
833.7	206	25	231
834.0	216	50	266
834.2	223	75	298
834.4	226	100	326
834.7	222	150	372
834.9	217	200	417
835.1	212	269	481
835.3	207	404	611
835.6	202	713	915
835.8	192	999	1191
836.4	181	2022	2203
836.9	163	3114	3277
837.3	150	4149	4299

SUMMARY OF PMF AND ONE-HALF PMF ROUTING

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION  JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1  A1   MISSOURI DAM SAFETY INSPECTION
    2  A2   WAHOO LAKE DAM (MO.30155)
    3  A3   PMF AND 50 PERCENT PMF
    4  B  300    0    5    0    0    0    0    0    0    0
    5  S1   5
    6  J    1    2    1
    7  J1   1   .5
    8  K       DA OPLD                                   1
    9  K1      RUNOFF CALCULATION FOR OAK PARK LAKE DAM
   10  M    1    2   .17             .17    1                   1
   11  P             26  100  120  130
   12  T                                                 -1   -87
   13  W2          .08
   14  X                   1
   15  K    1 OM OPLD                                    1
   16  K1      ROUTE HYDROGRAPH THROUGH OAK PARK LAKE DAM
   17  Y                             1    1
   18  Y1   1                                        -870.7   -1
   19  Y4 870.7 871.0 871.4 871.8 872.1 872.4 872.8 873.2 873.6 873.7
   20  Y4 874.1 874.5 874.8 875.0 875.4 876.1
   21  Y5   0   10   43   90   128  173  251  342  410  484
   22  Y5 607 744 843 949 3032 3667
   23  SA   0  4.5  7.5 10.0 16.5
   24  SE 850  860 870.7  875  880
   25  SS 870.7
   26  SD 875
   27  SB  10   .5  860    1 870.7  875
```

```
K          DA WLD                                                    1
K1        RUNOFF CALCULATION FOR WAHOO LAKE DAM
M        1        2      .21             .21        1
P                26      100      120    130
T                                                                   -1        -87
W2              .12
X                         1
K        2  OS WLD
K1        COMBINE THE ROUTED HYDROGRAPH AND THE RUNOFF HYDROGRAPH
K        1  OM WLD                                                   1
K1        ROUTE THE HYDROGRAPH THROUGH WAHOO LAKE DAM
Y                                  1        1
Y1       1                                               -829.4       -1
Y4   829.4    830.1    830.8    832.5    832.7    833.4    833.7    834.0    834.2    834.4
Y4   834.7    834.9    835.1    835.3    835.6    835.8    836.4    836.9    837.3
Y5       0       10       20      160      169      206      231      266      298      326
Y5     372      417      481      611      915     1191     2203     3277     4299
$A       0      3.0      9.0     12.0     14.5     16.5     21.0     31.0     41.5
$E     805      815      825    829.4    832.7      835      840      850      860
$$   829.4
$D     835
K       99
```

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	870.70	870.70	875.00
STORAGE	79.	79.	116.
OUTFLOW	0.	0.	949.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	875.36	.36	120.	2829.	.29	15.67	15.67
.50	874.24	0.00	109.	655.	0.00	15.75	0.00

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	829.40	829.40	835.00
STORAGE	113.	113.	193.
OUTFLOW	0.	0.	449.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	837.34	2.34	234.	4396.	5.00	15.75	0.00
.50	835.98	.98	209.	1487.	2.00	15.83	0.00

PERCENT OF PMF ROUTING
EQUAL TO SPILLWAY CAPACITY

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  21 APR 80
**********
    1    A1       MISSOURI DAM SAFETY INSPECTION
    2    A2       WAHOO LAKE DAM (MO.30155)
    3    A3       PERCENT PMF
    4    B   300       0       5       0       0       0       0       0      -4       0
    5    B1    5
    6    J     1       4       1
    7    J1  .30     .32     .33     .35
    8    K        DA OPLD                                                 1
    9    K1       RUNOFF CALCULATION FOR OAK PARK LAKE DAM
   10    M     1       2     .17     .17       1                                       1
   11    P            26     100     120     130
   12    T                                                             -1     -87
   13    W2         .08
   14    X                    1
   15    K     1  DM OPLD                                                1
   16    K1       ROUTE HYDROGRAPH THROUGH OAK PARK LAKE DAM
   17    Y                                    1       1
   18    Y1    1                                                  -870.7     -1
   19    Y4 870.7  871.0   871.4   871.8   872.1   872.4   872.8   873.2   873.6   873.7
   20    Y4 874.1  874.5   874.8   875.0   875.4   876.1
   21    Y5    0      10      43      90     128     173     251     342     410     484
   22    Y5  607     744     843     949    3032    3667
   23    $A    0     4.5     7.5    10.0    16.5
   24    $E  850     860   870.7     875     880
   25    $S 870.7
   26    $D  875
   27    $B   10      .5     860       1   870.7     875
```

```
K          DA WLD                                                     1
K1        RUNOFF CALCULATION FOR WAHOO LAKE DAM
M     1          2      .21                .21        1
P               26      100      120      130
T                                                              -1      -87
W2             .12
X                         1
K     2   OS WLD
K1        COMBINE THE ROUTED HYDROGRAPH AND THE RUNOFF HYDROGRAPH
K     1   OM WLD                                                      1
K1        ROUTE THE HYDROGRAPH THROUGH WAHOO LAKE DAM
Y                                  1        1
Y1    1                                                   -829.4       -1
Y4 829.4     830.1    830.8    832.5    832.7    833.4    833.7    834.0    834.2    834.4
Y4 834.7     834.9    835.1    835.3    835.6    835.8    836.4    836.9    837.3
Y5     0        10       20      160      169      206      231      266      298      326
Y5   372       417      481      611      915     1191     2203     3277     4299
$A     0       3.0      9.0     12.0     14.5     16.5     21.0     31.0     41.5
$E   805       815      825    829.4    832.7      835      840      850      860
$$ 829.4
$D   835
K     99
```

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	870.70	870.70	875.00
STORAGE	79.	79.	116.
OUTFLOW	0.	0.	949.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER-DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.30	873.22	0.00	99.	345.	0.00	15.83	0.00
.32	873.35	0.00	100.	367.	0.00	15.83	0.00
.33	873.41	0.00	101.	377.	0.00	15.83	0.00
.35	873.53	0.00	102.	398.	0.00	15.83	0.00

SUMMARY OF DAM SAFETY ANALYSIS

1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	829.40	829.40	835.00
STORAGE	113.	113.	193.
OUTFLOW	0.	0.	449.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.30	834.78	0.00	189.	389.	0.00	16.33	0.00
.32	834.99	0.00	193.	447.	0.00	16.25	0.00
.33	835.09	.09	194.	478.	.58	16.17	0.00
.35	835.24	.24	197.	574.	.92	16.08	0.00


DAT
ILM